May 1981
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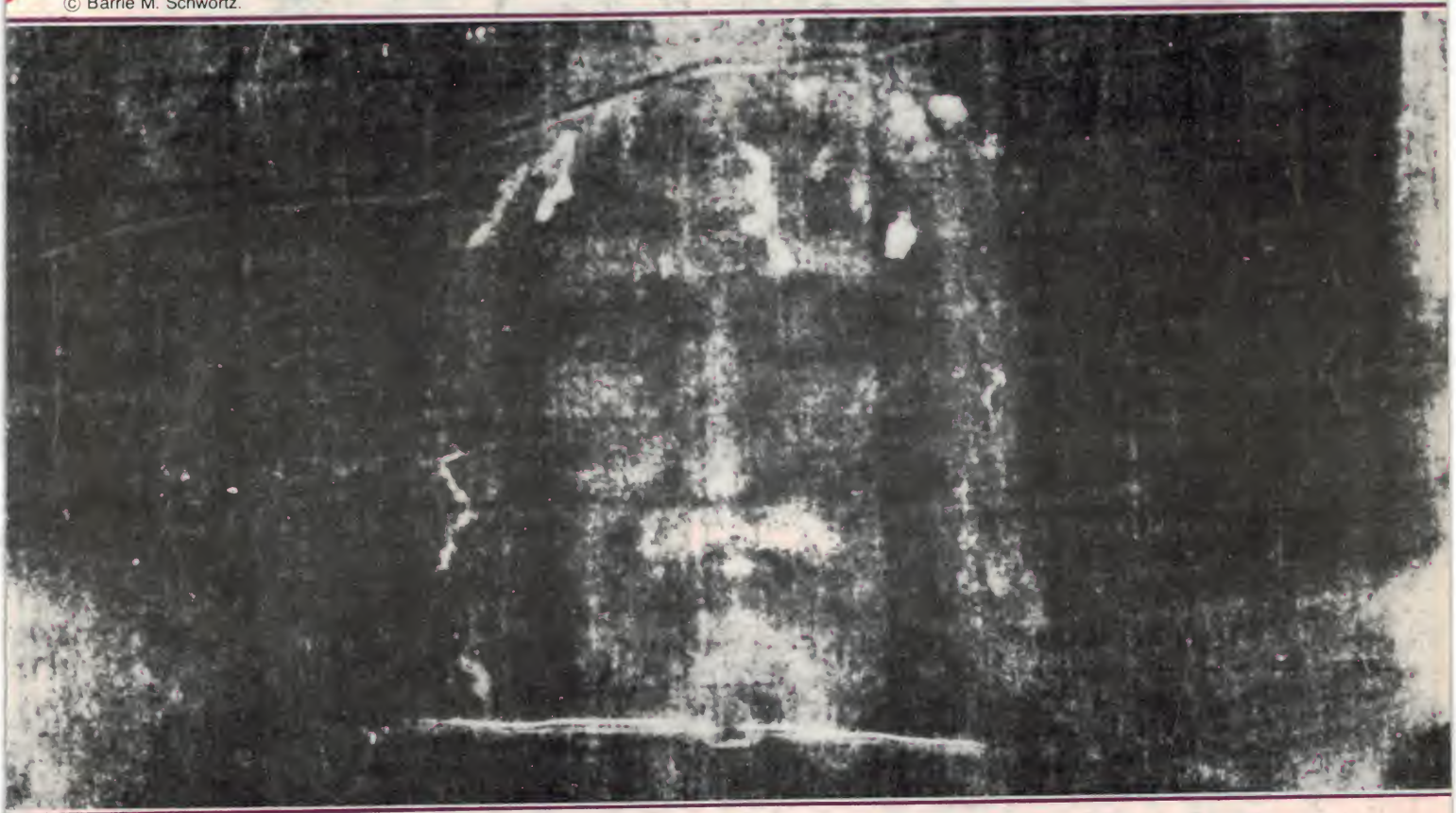
eti
ELECTRONICS TODAY INTERNATIONAL

# CHRIST -OR NOT?





## Scientists examine the Holy Shroud of Turin

**AN ETI EXCLUSIVE**

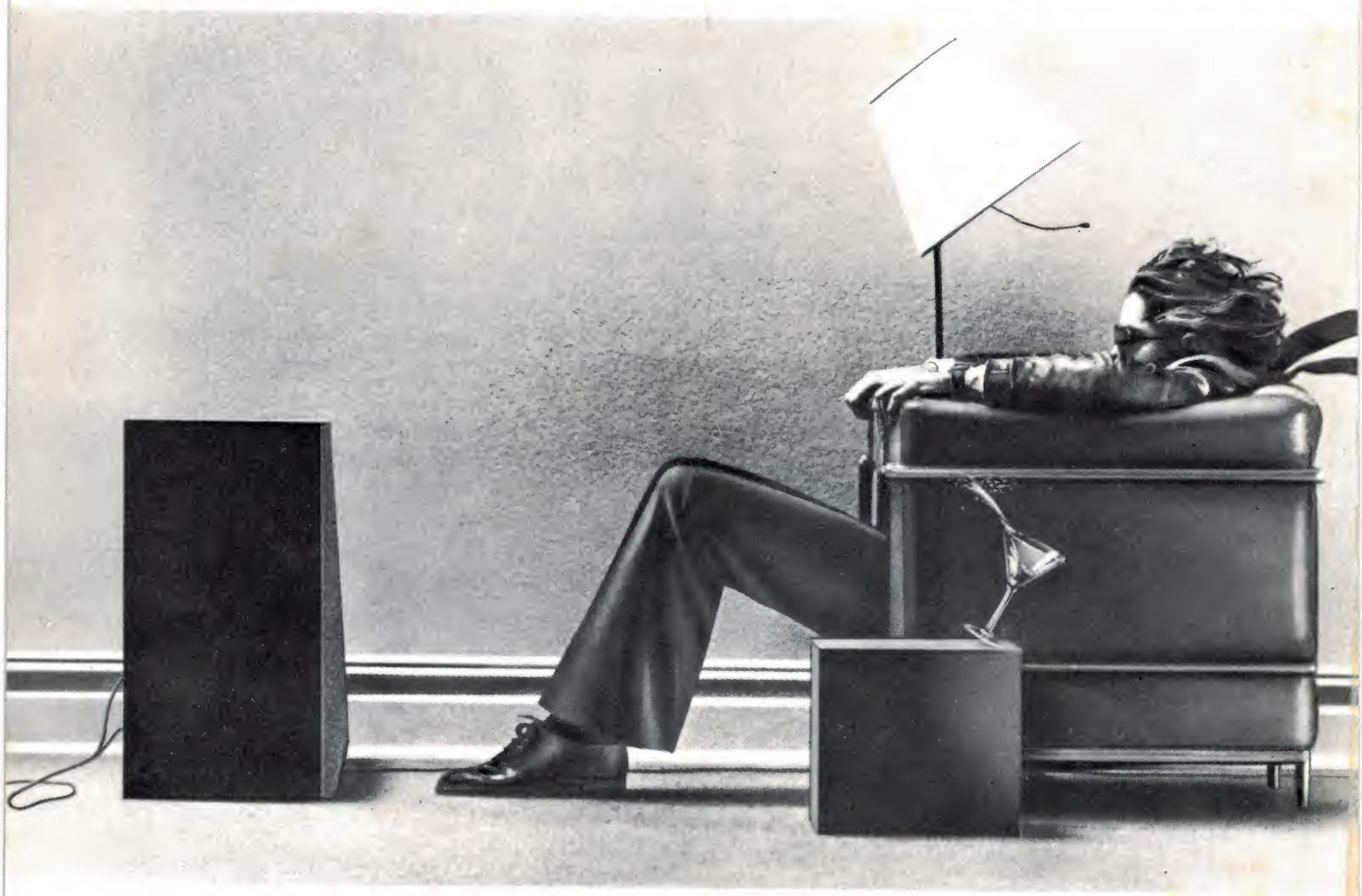
## UHF TV converter project

## Electronic humidity meter

## Videodisc-how soon?

## Sony's TA-F80 hi-tech amp

# AFTER 500 PLAYS OUR HIGH FIDELITY TAPE STILL DELIVERS HIGH FIDELITY.



If your old favourites don't sound as good as they used to, the problem could be your recording tape.

Some tapes show their age more than others. And when a tape ages prematurely, the music on it does too.

What can happen is, the oxide particles that are bound onto tape loosen and fall off, taking some of your music with them.

At Maxell, we've developed a binding process that helps to prevent this. When oxide particles are bound onto our tape, they stay put. And so does your music.

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# eti ELECTRONICS TODAY INTERNATIONAL

## QUICK INDEX



## BROADCASTING DILEMMA

IT IS APPARENT that television broadcasting in Australia has reached a crossroad — but it's no ordinary crossroad, it's a five-way junction! Television broadcasters, and listeners, have a number of options confronting them with regard to avenues for transmission and reception of programmes. These are: the existing 12-channel VHF system, a UHF system with over 35 channels available, direct satellite broadcasting, cable distribution or a 'mix' of these.

Cable TV is relatively remote, yet if any orderly mix of broadcasting avenues is to be looked at, it must clearly be a consideration. Satellite broadcasting, though, will be upon us later this decade, and that's not far away in planning terms. At present, UHF TV broadcasting is fulfilling an 'accessory' role. There is only one 'prime' broadcaster on UHF, the 'ethnic' station, channel 28, the others being translator services for existing VHF stations filling in where the VHF services cannot reach. The VHF system, introduced in 1956, amended in 1961, is currently in the process of being partially disassembled to make way for FM broadcasting.

The current disassembling of the old 12-channel VHF system by removal of channels 3, 4 and 5 to make way for the 88-108 MHz broadcast band has thrown the other options into high relief and this, coupled with the fact that channels 0 and 5A stations are to be phased out (see March issue, page 74 and this issue, page 81), has put enormous pressures on the existing TV broadcasting system.

The Federation of Australian Television Stations, representing the broadcasters as an 'industry', hosted a seminar in mid-March seeking ways out of their current dilemma, and we have a brief report of this on page 81. With direct satellite broadcasting fast approaching, the current broadcasters are seemingly caught between the devil — in the guise of channel reductions — and the deep blue sky! Although the satellite is suppose to provide services to those who cannot now receive them,many existing viewers could avail themselves of the opportunity. And they will.

While seeking solutions to existing problems, F.A.C.T.S. seeks to address themselves to the problems of an orderly introduction of UHF TV. But for the problems of VHF they seek solutions by proposing re-arrangements of the VHF channel allocations. It seems a short-sighted approach.

Meanwhile, the Department of Communications seems to have no really coherent attitude — let alone a policy. It came as shock news to those at the F.A.C.T.S. seminar that channel 5A was to be phased out — by direction from the Prime Minister. No time scale has been proposed, though. As I was composing this, I received a copy of a letter from the Minister of Communications, Ian Sinclair, sent to the Sydney Channel 0 Action Committee (see also March issue, page 74). Mr Sinclair says "... that while it is the Government's intention that multicultural television will eventually move to UHF only, I am not yet able to indicate when the channel 0 transmissions will cease."

At this time, the Department is also considering the Australian Table of Frequency Allocations following the WARC '79 recommendations, as well as a new Radiocommunication Act.

It is apparent that this is a critical time in the communications sphere in Australia, but especially in television broadcasting. The whole question requires some hard-nosed, dispassionate analysis in order to synthesise the appropriate solutions. And fairly soon.

Roger Harrison
Editor

# advertisers




eti ELECTRONICS TODAY INTERNATIONAL



# features

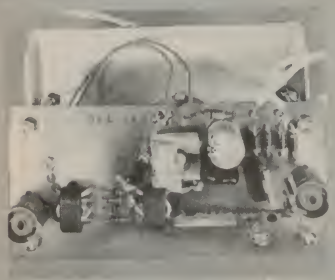


# computing

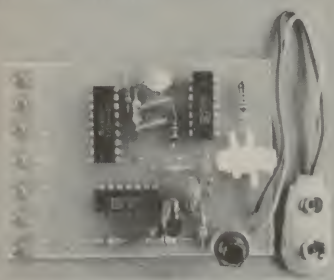


# news

# projects



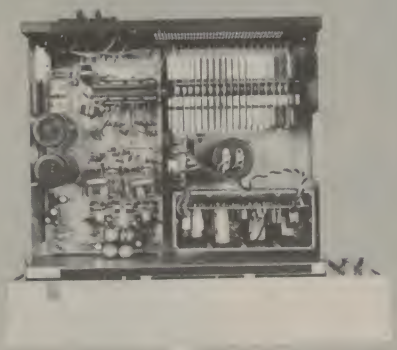






# sight & sound







# general





# next month

**TECHNICS' SB10 LOUDSPEAKERS**
We first introduced readers to Technics' revolutionary 'Honeycomb Disc' drivers, and the SB range of speakers, back in the May '80 issue and we have been hankering for some time to review the SB10s. What surprises will Louis Challis' spectral decay analysis have in store?

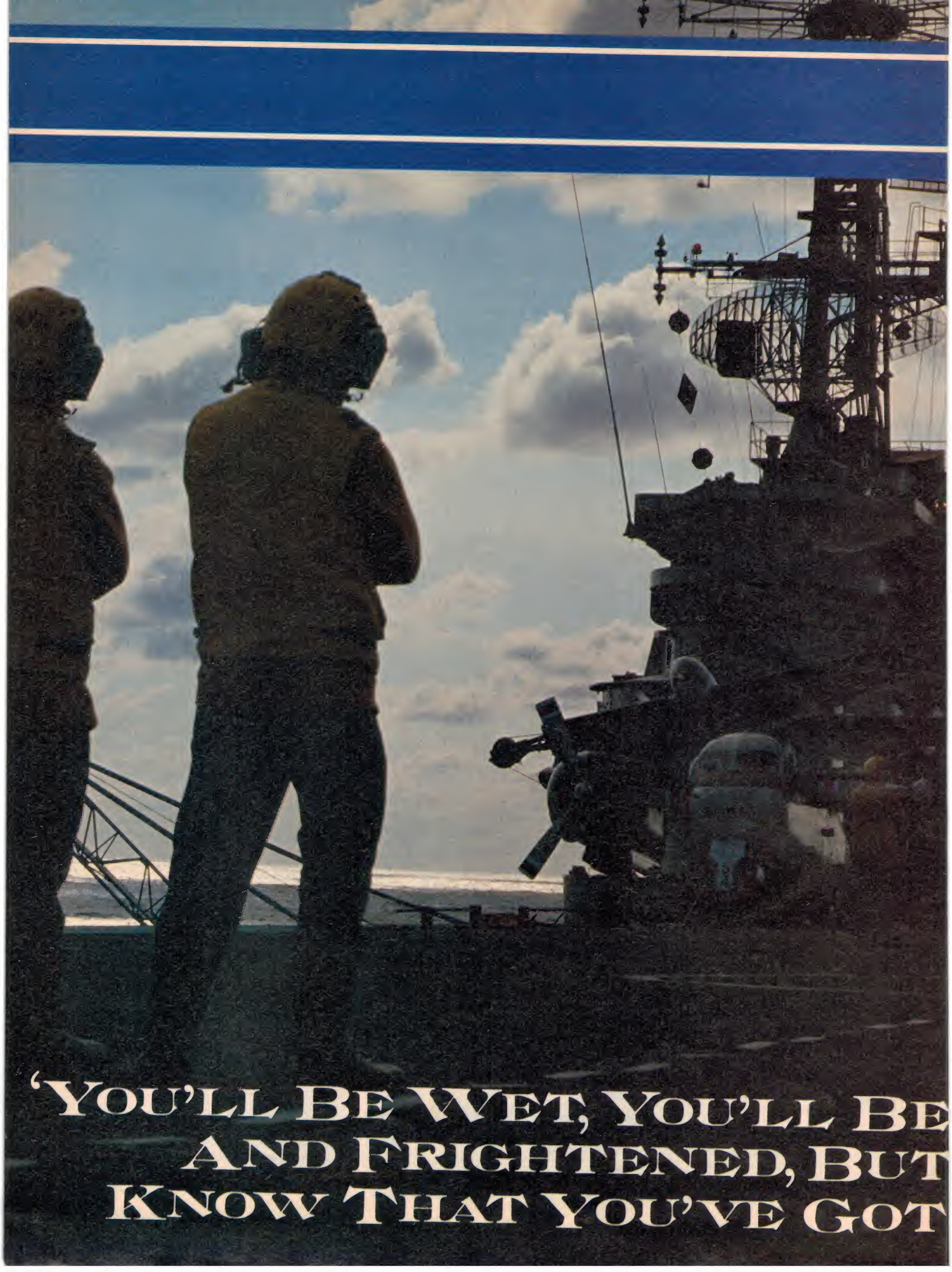
**ELECTROSTATIC DISCHARGE**
The nemesis of electronic systems — examined in depth! Most readers are familiar with the care one usually has to take with CMOS circuitry, but there's a whole lot more behind and beyond that. Our article examines how electrostatic charges can be built up and how to protect against the damage they can wreak.

**SERIES 5000 PREAMP/CONTROL UNIT**
Second in our series of 'no-compromise' audio units. David Tilbrook explains the philosophy and circuit techniques behind this top-line project. Features include a moving-coil cartridge preamp along with two moving-magnet preamps, a very versatile tape monitor scheme and a unique LED level meter that simultaneously displays peak and average programme level. Construction commences with the latter unit, which can also be used as a stand-alone instrument or incorporated in other equipment.

**A MICROCOMPUTER FOR BEGINNERS**
As explained this month, construction starts in the June issue. Featuring simple, single-board construction, low cost and expandability, this versatile little unit can be powered from a plugpack, will plug directly into your TV set for video display (colour too!), and includes an audio output.

**ADVANCED BASIC — PART 1**
For those personal computing buffs who've got beyond the basic BASIC. This series follows on from Phil Cohen's popular 'Back Door Into BASIC' series. If you've worked your way through that and itch to go further — Advanced BASIC's for you!

**Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.**


'YOU'LL BE WET, YOU'LL BE
AND FRIGHTENED, BUT
KNOW THAT YOU'VE GOT

# NAVY

THE PRIDE OF THE FLEET IS YOU.

## HOMESICK YOU'LL A TOP JOB.'

'In the days when our Navy was young,
and the ship was the pride of the fleet.

You'd gaze out at her in wonder,
made an old sailor's heart skip a beat.

Well the ships have gone through
some changes,

And the roles have changed a bit too.

You'll be wet,

You'll be homesick and frightened,

But the pride of the fleet will be you.'

Our ships are equipped with some of the finest and most advanced technology in the world. So it stands to reason that we're proud of them.

It also stands to reason that we need the men to make them work.

Men who, in the Navy, have discovered what they do best and have been trained to achieve it.

Men with pride in themselves and what they can do. Whatever the conditions.

Because pride is what it's all about really.

In the Navy we're proud of the Fleet. But we're prouder still of the men who work it.

Talk to a Navy Careers Counsellor. He'll tell you about today's Navy and the kind of men that it needs. It could be a proud moment for you both. So, pick up a phone now. Or write to G.P.O. Box XYZ in your state capital.

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Auth. Director-General Recruiting, Dept. Defence. NGE249.DPS.21


UPON RECEIVING YOUR INHERITANCE
IT'S ALWAYS WISE TO STUDY THE FINE PRINT CAREFULLY.

# Chip shop for Canberra ?

The Federal Government has invited National Semiconductor to examine the feasibility of establishing a silicon wafer fabrication plant in the Australian Capital Territory.

**Announced in the fourth week of March by the Minister for the Capital Territory and Minister Assisting the Minister for Industry and Commerce, Mr Michael Hodgman, the news brought some criticism from South Australian and Queensland politicians.**

Mr Hodgman said the Australian Government had indicated its willingness to seek an agreement with Natsemi on the basis that it would provide land and buildings (estimated to cost $19 million), in return for which Natsemi would commit itself to the transfer of existing and future technology, 'most favoured customer' access to products, assistance with product development and the training of Australians.

Mr Hodgman said that Natsemi would employ 1200 people in operating the plant, and at least a further 800 jobs would be created by demands associated with the new industry. Construction of the plant would employ 300 people over 18 months.

"Capital cost of the project is estimated at $100 million and would involve the construction of an 18 600 square metre complex housing a fabrication plant, a central servicing unit, and office space," the Minister said.

Natsemi expects to complete their feasibility study around the middle of the year and have a decision on whether the project will proceed at that time. However, Mr Jack Rutherford, Managing Director of Natsemi Australia, was in no doubt that he would get his board's approval. Natsemi's head office in Santa Clara, California's famed Silicon Valley, is familiar with the proposal.

Following the announcement, some observers were wondering why Natsemi had chosen Canberra after it had apparently had counter offers from a range of other contending countries offering millions of dollars worth of concessions. It appears, however, that the answer is quite simple. Australia offers undoubted advantages in the way of a stable political climate, sound investment environment and a growth economy. But the concessions offered are not that different from those offered elsewhere. Behind the $19.5 million offer lie a string of entitlements which have yet to be added up.

It appears that the following forms of assistance have been offered to Natsemi:

- Research and development grants.
- Export expansion grants.
- Investment allowance tax write-offs.
- The opportunity to apply to the Tax Commissioner for special depreciation write-offs to apply to the economic life (as opposed to the physical life) of the plant, and
- Training allowances for staff employed.

While local firms can get similar assistance, the difference between Natsemi and local firms is that while these forms of assistance are available to the latter, they rarely get a head-start by Government providing free land and buildings for them.

It is difficult to assess with any accuracy just what the money value of the industry incentives will be since there are as yet no publicly available figures on the likely value of output, the number of the 1500 staff who will receive specialist training, the planned investment in plant or the likely response of the Taxation Commissioner to an application for accelerated depreciation rates.

What has been causing concern within the Public Service, however, are the equally vague indications of what Australia will receive in return.

Natsemi has yet to inform the Government exactly what kind of chips it will manufacture, and there seems to be very little pressure from the plant's enthusiasts (of whom there are plenty) for them to do so.

However, the entire utility of the scheme depends almost totally on the technology transfer benefits which its advocates say will accrue to Australian manufacturers.

One Canberra source deeply involved in the project said recently that Natsemi had given an undertaking that the plant will involve VLSI (very large scale integration) technology but has not committed itself to details such as whether bipolar or MOS modes will be employed.

Natsemi has apparently told the Government that this decision will be made later, after world market requirements are assessed.

Nor is it clear how much, if any, capital Natsemi itself will outlay, although it has been promised loan-raising assistance from the Australian Industry Development Corporation (AIDC) should it require it.

Australian firms will be required to buy the plant equipment and lease it to Natsemi and presumably the leasing fees will be tax deductible.

It has perhaps not been appreciated that the Natsemi plant will be merely an off-shore operation for the Silicon Valley major operation of the corporation. It will fabricate silicon wafers for export only and has no obligation to manufacture for the local market.

The 'encapsulation stage' of the silicon chip production process — where the chips are separated from the wafers — will take place in low-wage, tax-free Singapore.

The aspects of the deal which excite its promoters so much are the two concessions Natsemi has offered.

One is the status of 'prime customer priority' for Australian manufacturers wanting to buy other Natsemi components (which will be able to be purchased from a central clearing house to be established by Natsemi).

The second concession will be the establishment of a technology exchange corporation (which will be operated on a 50/50 basis by Natsemi and Australia) whereby Australian manufacturers can acquire advice, for a fee, on re-design and new design of microcircuitry applications to existing products.

The Queensland Treasurer, Dr Llew Edwards, has attacked the Government's decision to site the plant in Canberra and criticised the assistance, saying it was two-faced for a Federal Government which has attacked State Government incentives to new high technology industries such as aluminium smelters to do the same thing. Such criticism is predictable, yet the proposal succeeded despite intense bureaucratic opposition, it seems.

It's not likely to gladden the hearts of Philips' Australian board, or AWA for that matter. Philips closed down their Hendon, S.A., plant around a year ago and AWA is struggling to find customers for their custom chip design facility.

It will be interesting to see what happens in a few short months when Natsemi come back with their feasibility study results.

# NEWS digest

## New range of Yew multimeters

**The Yew 2410 series of multimeters, just released by Parameters Pty Ltd, is intended for professional use in maintenance, test and service situations.**

All feature taut-band suspension, a technique pioneered by Yew and used in many of their instruments. Other features include a common ac and dc scale with white lettering on a black background to emphasise the position of the pointer.

In all, five different models are available. Movements are diode protected with additional fuse protection against overloading. Scales are colour-coded with the selector switch to simplify readings, and a single switch is used for all range and function changing.

Cases are made in tough high-impact plastic, and a vinyl carrying case is supplied as standard.

A detailed colour brochure on the Yew 2410 series of multimeters is available from Parameters Pty Ltd — phone Sydney (02)439-3288 or Melbourne (03)90-7444.

## Now it's microprocessor 'phones!

**It had to come — the microprocessor telephone. But this latest electronic wonder is not just a telephone with memory, auto-dialler, etc — it's the complete bedside companion!**

The Superphone 7700, just released here by Supertel Australia, features an auto-redialler, a stopwatch, a calculator, a digital clock and an alarm clock. And it's Telecom approved, according to Supertel.

The memory dialler enables you to store the 20 numbers you call most frequently — each number can be up to 14 digits long (ISD!). The number you select is displayed on the 14-digit LED display as Superphone dials it.

The auto-redialler stores the last number you dialled, whether you dialled it manually or recalled it from the memory. All you do is pick up the receiver, press the 'redial' button and the last number called is displayed and dialled automatically.

In addition, the Superphone includes a stopwatch so you can time calls up to 99 mins 59 secs; a four-function, eight-digit calculator; a crystal-controlled digital clock and an alarm operated by the clock. Just to make sure the phone operates during power failures, standby batteries are included.

Full information can be obtained from Supertel, P.O. Box 215, Rose Bay 2029 NSW. (02)81-3007.

## Turning on the aurorae

**Experiments conducted by Canada's National Research Council Herzberg Institute of Astrophysics in the upper atmosphere have exceeded all expectations.**

Their 'Waterhole' project involved seeding the Earth's ionosphere with water molecules at a height of about 300 km over as wide an area as possible.

The seeding was done instantly with a high explosive rocket warhead which caused a dimming of the aurora by some 50% throughout the area scanned by rocket-borne and by ground-based instruments.

This temporary intervention in the high-atmosphere processes which create the Northern Lights also produced perturbations in the particle and magnetic flux measurements in the area.

If these first results are confirmed by similar future rocket experiments, then the National Research Council of Canada's researchers will be sure they have somehow influenced the high speed particles that induce the aurora.

They forecast that it may even be possible at some future date to dim or brighten the aurora or even turn the lights on and off again at will.

The same would apply in the Southern hemisphere.

**Brian Dance**


## New range of panel meters features taut-band suspension

**A new range of English-made SIFAM meters has recently been released by C & K Electronics.**

Featuring taut-band suspension, the SIFAM meters are available as dc or ac voltmeters, millivoltmeters, ammeters, milliammeters and microammeters. Some models are available for special requirements such as dB meters or temperature indicators.

Apart from the standard pointers and scales fitted to the meters, many other types of pointers are available and scale markings (including colour printings) can be provided to suit individual requirements. Mirror scales and meters with centre or right-hand zero can also be supplied. Customers' names or logos can be printed on dials to order. Illumination is available, if required, on most types.

VU meters and peak programme meters are generally available to the relevant specifications. A special low cost audio level indicator with VU scale is available with modified ballistics.

For further information, including a very informative catalogue, contact C & K Electronics (Aust.), P.O. Box 101, Merrylands, NSW 2160. (02)682-3144.

# Science prize for students

**The first BHP Science Prize, to be awarded in May 1982, is being wholeheartedly backed by both the CSIRO and the Australian Science Teachers' Association.**

Areas of scientific research are biology, chemistry, geology, physics, or a combination of these, and students are eligible if they are under 19 on Jan 1 1981 and attending a registered Australian primary or secondary school or secondary college during 1981, either full or part-time.

The winner will receive $5000 plus a gold medal; second prize is $1000 and a silver medal, third prize $500 and a bronze medal.

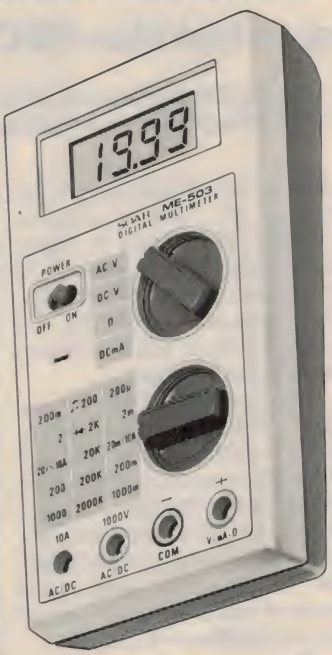
According to the CSIRO, the aim of the competition is to "encourage young scientists in the pursuit of excellence in the biological and physical sciences".

Entry forms may be obtained from members of the Australian Science Teachers' Association in each state.

# Low-cost Japanese multimeters

**GFS Electronic Imports of Mitcham, Victoria, recently announced they would soon have available two handheld digital multimeters manufactured by the well-established Japanese electronics instrument maker, Soar Corporation.**

The ME-501 and ME-503 are both 3½-digit DMMs with liquid crystal displays. They employ LSI solid state technique and are consequently highly durable, with a battery life of up to 200 hours, according to GFS. Low battery and automatic polarity indication are provided for in their displays, all ranges are fully overload protected, and zero adjustment is automatic.




The ME-503 (photographed) reads ac and dc voltage up to 1000 V, and ac and dc current up to 10 A, as well as resistance. Input impedance on the ac and dc voltage ranges is 10 megaohms. The ME-501 is similar except for having only two ac voltage ranges, 200 V and 1000 V.

The expected selling prices are $135 + sales tax for the ME-503 and $99 + sales tax for the ME-501.

For further information contact GFS Electronic Imports, 15 McKeon Rd, Mitcham Vic. 3132. (03)873-3939; telex AA38053 GFS.

# Heathkit earth station?

**American sources advise us to look for Heath to add a low-cost satellite earth station kit to its Heathkit line of build-it-yourself electronic products.**

The Benton Harbor, Michigan, subsidiary of Zenith Radio Corp. is eyeing the market for direct satellite TV viewing at home and could be ready with a product by late this year or early 1982. Early speculation is that it will sell for less than US$10 000.

# People, products and appointments

**Soanar Electronics have been appointed as sole Australian and New Zealand agents for Supertex Inc. of the USA. Supertex manufacture a wide range of N-Channel and P-Channel VMOS power FETs specially designed for applications requiring high input impedance and fast switching time, and programmable encoder/decoders for CMOS PROMs.**

Mr James Donnelly has been appointed national manager, technical services, of Bell & Howell Australia Pty Ltd. He will be directly responsible to Bell & Howell Australia's general manager, operations, Mr John Londregan. A graduate of the RMIT in industrial electronics, Mr Donnelly has also taken a post-graduate course in electronics at the Gordon Institute of Technology and gained his certificate from the School of Small Business Studies. Prior to joining Bell & Howell, he was an executive of A-M International for 21 years.

**David Christopher, former managing director of Tandy Electronics in Australia, has been named vice president of Tandy International Electronics, a new position. He will head retail operations in Australia, Belgium, Canada, France, Germany, Holland, Japan and the United Kingdom.**

BWD Instruments, who have 25 years of experience in the electronics field behind them, are approaching the 1980s with a new, vigorous management team headed by John Opie and Ron Wheeldon as joint managing directors. BWD won the Design Award of the Australian Industrial Design Council for their 880 Powerscope, and are at present trying to enter the American and Japanese markets to consolidate their success in the southern hemisphere. Philip Cohen as newly created Corporate Development and Marketing Manager will be responsible for the marketing effort and increased production.

**Tecnico Electronics have been appointed Australian distributors for Tekel handheld digital tachometers for rotational or peripheral speed measurement. Two models are available — a mechanical contact type and a non-contact infrared device.**

In March this year the A & R Soanar Electronics Group opened their Queensland branch and warehouse complex in Brisbane. The Group now has branches in all mainland states of Australia, and like the other branches the new Queensland setup provides field representation, a showroom, telephone sales and warehouse facilities.

**Dick Smith Electronics Pty Ltd plans to open a sales office in Auckland, New Zealand, early this year. Dick Smith visited New Zealand in 1980 to gauge prospects, and was swamped by calls and letters from the public there wanting to know when Dick Smith Electronics would open in New Zealand. Initially the NZ branch will concentrate on distributing a selected range of Dick Smith products to NZ resellers, but a retail outlet should follow shortly. Dick Smith Electronics hope to gain skills and experience in this New Zealand venture which will enable them to achieve their ultimate goal of opening in the US by 1984. Mr David Milson, a Dick Smith company executive with many years of experience in Australia, will become the resident manager of the New Zealand operation until he has trained a New Zealander to take over the position.**

Dick Smith Electronics also recently opened a new store at 145 Parramatta Road, Auburn (phone 648-0558), to serve Sydney's Western Suburbs. The store will be open seven days a week and has plenty of parking available. Manager will be Ilidio Teixeira, formerly manager of Dick Smith's Parramatta store.

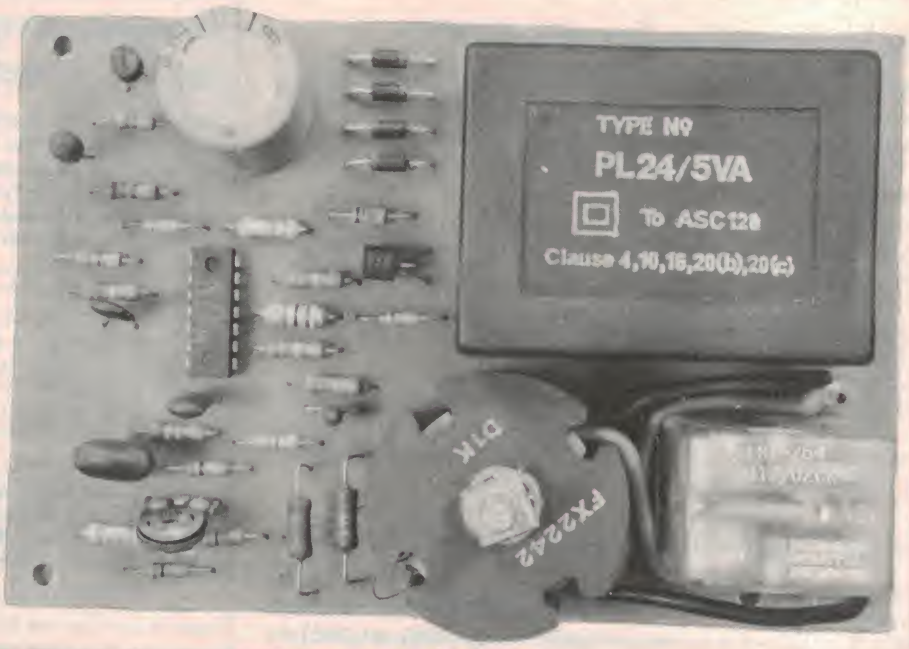
## ERRATA

A rather obvious, but potentially dangerous error occurred in the circuit on the top left of page 60 ('Power Monitor') in the March issue. It shows the mains active input connected to the earth at the output. The mains active input should instead go to the fuse. Correct your copy now. Correction slips were inserted in the majority of copies distributed.

### AAAARRRGH !

Every now and then, it's the little things in life that get to you. This month (or last month, really) it was the picture on page 38 of the April issue, showing the pc board for the ETI-567 Core-Balance Relay. Just in case you hadn't noticed, look carefully and you'll see the writing on the potcore and the transformer is laterally reversed. In the trade (as they say . . .) this is known as a "flopped pic". Sometimes we'd like to do the same thing to the person responsible. Here it is (hopefully, this time . . .) the right way round.

That wasn't the only thing the wrong way round. The two red wires from T2 (L1) are shown incorrectly on the overlay, page 39, and the picture. Transpose them for correct operation. The picture at right is correct. The How It Works is correct, but the dot on the top wire of L1 on the circuit should go on the lower wire.




### ERRATA, page 17, April

The caption beneath the chart at the top right of page 17 contains an error. The fourth line should read ". . . balanced positive-to-negative ion ratio of 1.2:1.0 . . .".

# Telidon given world standard rating — but the ABC does different

**The plenary assembly of the International Telegraph and Telephone Consultative Committee (CCITT) ratified in December 1980 the Canadian videotex (two-way TV) system, Telidon, as one of the world standards, alongside competing French and British systems.**

Canadian representatives displayed Telidon in Australia in February this year with a view to making their system the adopted standard in this country.

Telidon can be used at home, in business and in education, and according to its developers is a highly flexible, efficient and easy to use system that adapts easily to many uses and transmission methods, as well as having been designed to be immune to technological obsolescence. Information can be displayed in textual, graphic or photographic form.

It can provide access to the data banks of libraries, stock exchanges, newspapers, weather offices, advertising directories, government agencies — in fact to virtually any computerised information system. As an interactive computer system, Telidon can be used for services such as electronic mail, teleshopping, telebanking and home video games.

Telidon was first demonstrated in Australia in August 1979, but since that time has made many advances, both technologically and in distribution. As well as having been approved as an international standard, Telidon systems have been sold for use in Washington in the USA and Caracas, Venezuela; a Telidon demonstration system is fully operational in Switzerland; Telidon technology is an integral part of new cable TV networks proposed in several US cities; and major home computer firms in North America are designing equipment and software that will allow more than one million home computers in the US to take advantage of Telidon's data storage and image creation technology. Teleglobe Canada has also announced a C$4.1 million project to establish a 100 000-page Telidon data base for the international videotex market.

Within Canada hundreds of terminals have already been installed across the country, and dozens of companies are involved in Telidon projects. Telidon information is being transmitted by satellite, TV broadcast, telephone lines, coaxial cable and optical fibre. The cost of Telidon sets is declining as demand increases.

The Canadian developers regard Telidon as ideally suited to be the videotex standard for Australia because they say it was developed with the broadest possible range of applications in mind, is immune to technological obsolescence, and each piece of equipment can be used for many different functions.

However, despite all this heavy propaganda for the Canadian product, the ABC has decided to go its own way and start field trials of the competing French system, Antiope.

Some Australian TV channels have already been testing the British Teletext system, but since this system was designed for use with UHF TV channels it is unlikely to be the most appropriate for the ABC, which largely uses low-numbered channels. Using the British system on Channel 2, tests have shown that the data may be easily distorted in its passage from the transmitter to the TV set, causing a high probability of errors or omissions.

With the French Antiope system, rows of alphabetical characters and other data are transmitted without the need to synchronise them with the TV line structure, as must happen with the UK Teletext. Antiope displays 40 characters on each row of the 'page' as does Teletext, but the French system allows reduction in the speed of transmission to minimise the number of errors — a vital consideration in such things as stock exchange listings, where an error in a single digit could be vital. If the ABC's field trials of Antiope are a success, it will recommend that the French system be given careful consideration by the Department of Communications for adoption by Australia.


# Music, Murder, Money and Mirth

With these exciting new movie releases from Magnetic Video. Reprinted on top quality videotape. Slot in the video cassette, switch on and settle down to a night of uncensored entertainment.

**Beyond the Valley of the Dolls.** An all-girl rock trio and their manager meet bizarre characters, and murder in Hollywood. Stars the voluptuous Edy Williams, Dolly Reed and Cynthia Myers. **Myra Breckenridge.** The story of a young homosexual man who undergoes a trans-sexual operation. Stars Rex Reed and Raquel Welch. **Julia.** Academy Award winner, set in the turmoil of World War II and Nazi Germany. A young writer is asked to smuggle money into Berlin. Stars Jane Fonda and Vanessa Redgrave. **Breaking Away.** Comedy about an illusive high school graduate's addiction to bicycle racing. Stars Dennis Christopher, Dennis Quaid and Daniel Stern. **There's No Business Like Show Business.** Irving Berlin's classic musical comedy about a 'show biz' family. Stars Marilyn Monroe, Ethel Merman and Johnny Ray.

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MAG011

# The Holy Shroud of Turin

Since its mysterious appearance in the fourteenth century, the piece of linen cloth with the strange image of a crucified man, now known as the Holy Shroud of Turin, has elicited awe, disbelief, scepticism, and scientific curiosity. Its history and its authenticity are, as one scientific punster put it, "shrouded in mystery". This article fills in some background on the Shroud, including its known and conjectured history and the conclusions — or lack of them — of scientific investigations up to the latest scientific enquiry of 1978.

**Jane Clarke (B.A. Hons)**
**— Production Editor, ETI Group**

THE HOLY SHROUD of Turin is kept, well wrapped in silk, asbestos and lead, in the Royal Chapel of Turin's Cathedral of St. John the Baptist, which has been its home since 1578. Officially the property of the House of Savoy, former rulers of Italy, the Shroud has for centuries been equally jealously guarded by the Catholic Church, who have seldom allowed it to be viewed by the general public and have consistently shown resistance to scientific examination which might prove, once and for all, whether the Shroud is at least authentically from the time of Christ or whether it could be the work of a mediaeval forger. Even on its first appearance in the West in the fourteenth century there were doubters of its authenticity, notably Bishop Henry of Poitiers around the middle of the century, and some years later the Bishop of Troyes, Pierre d'Arcis, both of whom tried to stop the exposition of the Shroud on the grounds that it was not genuine.

This cloth that has caused so much controversy is a piece of linen a little over 14 feet long and about a yard wide — in excellent condition considering its supposed age — which bears on it an image, formed by some unknown means, of a crucified man. The man appears to have been laid on his back on the cloth, which was then folded over his head to cover his front, since there is a complete image of both the front and back of the body.

The colour of the imprint is best described as a sepia monochrome with variations in the intensity of the colour, but there is no clear outline of the body; the impression is rather of a blurry, almost impressionistic figure, which melts away into insubstantiality as one comes closer to it.

The man of the image was about 181 cm (5ft 11in) — tall for his supposed time, but not impossibly so — with a powerful and well-proportioned



**Photographs of the frontal and dorsal images on the Shroud taken with reflected light. This is how the Shroud appears under normal viewing con-**

physique. A leading ethnologist has described him as "of a physical type found in modern times among Sephardic Jews and noble Arabs", and his age has been estimated as between 30 and 45. There is a good deal of evidence that this man was a crucifixion victim, and there are also traces of what could be taken to be blood spilled due to the Crown of Thorns, the scourging, etc. that Christ is said to have undergone.

There is no definite evidence in the Gospels that Christ would leave a 'sign' like this Shroud of his resurrection; mention is made of the disciples finding 'othonia' (linen bands used to bind the body according to Jewish ritual) and a 'soudarion' (sweat cloth) in the tomb, but these cannot be specifically tied in with the Shroud, as there is no mention of any image left on them. Many people, however, have discovered in the Shroud details which correspond closely to the description in the Gospels of what Christ underwent before death, and most of these people would welcome a comprehensive scientific examination of the Shroud in order to at least discover whether this apparent miracle could in fact be man-made.

## Scientific investigation

True scientific investigation of the Shroud really only started in 1898, when Secondo Pia used the new science of photography to take pictures of the Shroud — and discovered that the image was a negative one. Instead of the masklike, ghostly appearance of the Shroud, the man stood out on photographic negatives as a positive, lifelike image — especially the face. This discovery alone makes the likelihood of the Shroud's being an artist's forgery much more remote; it would be practically impossible for any artist to reproduce tones that are the reverse of all he has learnt to depict in nature, especially without the photographic means of checking his work. Besides, who would *want* to produce artificially such a negative image?

Medical men have also shown a good deal of interest in the Shroud. They claim that the anatomical data of the image would be far beyond the capabilities of any fourteenth century artist, judging from what contemporary works show us of the prevailing knowledge of anatomy. They also deduced from experiments that a crucifixion victim would have to be nailed through the wrists, as is the man of the Shroud, since the palm of the hand would not be strong enough to bear the weight of the body. Subsequent discovery of a crucified man proved them to be right — but would a mediaeval forger have known this, considering that all contemporary portrayals of the Crucifixion show nails through the hands?

Angles of blood flow also indicate crucifixion, and markings on the forehead and in the side would correspond exactly with wounds Christ is said to have received.

In tests done before 1978, no trace of pigments has been discovered, as would be expected if the Shroud were the work of an artist. As well, it has been discovered that whatever caused the image has not penetrated right through the fibre of the linen, nor has it encrusted between the fibres. This would also seem to rule out paint, or any kind of 'wet' process of image-formation.

Analysis has been made of the weaving of the linen to try and trace its origins. Whilst the style — a three-to-one herringbone twill — is unusual in linen, it is by no means unique, and could certainly come from first-century Palestine. Whilst the linen was being examined, minute traces of cotton were also found, suggesting that the linen had been woven on equipment also used for the weaving of cotton. By analysing the species of cotton, scientists determined that it originated from the Middle Eastern area. Whilst a forger might have gone to the length of obtaining a piece of linen from this precise area, it is one more piece of evidence pointing towards the authenticity of the Shroud's provenance.

Up till 1978 scientists had been unable to identify any actual blood on the Shroud; it has been conjectured that either the age of the cloth or the fire and water damage it sustained in the sixteenth century might account for this, but since there is in any case no sign of penetration of any liquid into the cloth, it is arguable that scientists might perhaps not expect to find traces of actual blood.

The Shroud was also subjected to pollen-testing by means of removing surface particles from it on pieces of sticky tape. Dr. Max Frei of Switzerland in this way determined four predominant areas where the Shroud had been in its history: near to the Dead Sea in Palestine; in the area of the Anatolian steppe; Istanbul; and Northern Europe. The latter corresponds to our knowledge of the Shroud's history, but the other areas could offer vital clues to its earlier existence. ▶

**ditions. Shroud is mounted on a specially constructed stainless steel table and held in place with magnets to avoid damage to the cloth.**



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**When the right arm is positioned as it would have been during the crucifixion the blood flows are clearly seen to be vertical. Note the wound in the wrist, presumably from being nailed to the cross, *not* through the hand as traditionally depicted.**



One important test that has not yet been carried out is carbon dating, which could tell us the age of the cloth to within ±100 years. This has until recently been resisted by the Church as it would have necessitated large areas of the cloth being destroyed, but now that carbon dating techniques have advanced, minute threads are enough to enable a dating, and the Church has at last given permission for this to take place.

In recent research using image-intensifying and other equipment associated with the American space project, scientists have come to the conclusion that the image must have been created at a distance by some form of emanation, rather than by contact. This was borne out when, using an Interpretation Systems VP-8 Image Analyser, the image was shown to contain perfect three-dimensional information. An ordinary two-dimensional picture or photograph does not contain enough information relating to distance and proportions to be immediately translateable into a meaningful 3-D image. The fact that the Shroud image does must add considerably to the likelihood of its not having been the work of an artist.

## The Shroud's history — known and conjectured

The Shroud appeared in Western Europe in the mid-1350s as the property of a chivalrous but poor French knight, Geoffrey de Charny. How it came into his possession has never been explained, but he (or more probably his widow Jeanne de Vergy) was responsible for its first exposition. It passed from him to his son, also Geoffrey, and then to his grand-daughter, Margaret, who finally entrusted it to the keeping of the House of Savoy in 1453. The Shroud was damaged by fire and by the water used to douse it in 1532, and although the triangular patches so evident on all photographs were necessary to repair the cloth after this, the image itself received little damage.

However, it is largely the mystery surrounding its sudden appearance in a relatively humble family in the fourteenth century that has caused so much doubt to be cast on the Shroud's authenticity over the succeeding centuries — apart from the scepticism of those who find 'miraculous' happenings in any case worthy of doubt. In his book *The Turin Shroud*, Ian Wilson has made a highly credible attempt at discovering the history of the Shroud before the fourteenth century and explaining its mysterious reappearance. To do this he largely uses the evidence of art history to substantiate his theory.

There is a legend, substantiated by some ancient writings, of King Abgar V of Edessa (a prosperous town beyond the borders of the Roman Empire) having corresponded with Christ and later, after Christ's death, having been presented by a disciple, Thaddeus, with some kind of holy or miraculous image of Christ's face. When some years later a king who was hostile to Christianity succeeded to the throne, this 'image' was hidden in a bricked-up niche in one of Edessa's city gates — where it remained, hermetically sealed and beautifully preserved, until around the year 525.

By the time of its rediscovery Christianity was well established in both eastern and western Europe, and the image was immediately revered and worshipped as being an image of Christ 'not made by hands'. It was accredited with miraculous protective powers, and many copies were made of it. The strange thing about this image, which came to be called the Mandylion, was that in many details it resembles exactly the face on the Shroud.

There is no account anywhere in the Gospels of what Christ looked like, and until about the sixth century there had been no tradition or consensus of opinion about this in art. However, around the sixth century likenesses of Christ which correspond in too many details for coincidence to the image on the Shroud start to appear in both Byzantine and western art. They date from the discovery of the Mandylion, supposedly an image 'not made by hands', which would therefore be regarded as the definitive true image of Christ — but they are also identical to the image of the Shroud. Wilson draws the obvious conclusion: the Mandylion and the Shroud are one and the same.

His conjecture is further substantiated by the fact that the Mandylion disappeared from Constantinople (where its home had been since 944) during the sack of that city by the Crusaders in 1204, and has never been rediscovered since. Wilson speculates that the Mandylion/Shroud could have fallen into the hands of the Knights Templar, a religious and chivalrous organisation which was finally quashed by Philip the Fair of France. The Templars were reputed to have strange religious and initiation ceremonies which included the worship of a 'head' — an image of some kind. This of course laid them open to the charge of heresy,

**The Shroud is removed from the backing board, which it had been fastened to for public display, by two of the Poor Clare nuns who are responsible for care of the Shroud. In rear pictured left to right: Gabriele Porratti (Italian scientific team) and Don Devan (American scientific team).** *© 1978 Barrie M. Schwortz*

and Philip delivered them not unthankfully to the Inquisition whilst pocketing their considerable wealth.

The treasury of the Templars had been at Acre, on the eastern Mediterranean coast (close to the Gospel areas); from there it had moved to Cyprus and thence to Paris, but the 'image' or 'head' they were said to worship was never found. Descriptions of it, however, make it sound distinctly like the image on the present-day Shroud: it was said to be blurry, pale, indistinct, and many of the features, e.g: the forked beard, correspond exactly.

In 1314 the Templars' Master of Normandy, one Geoffrey de Charnay, was burnt at the stake in Paris; some 40 years later the Shroud as we know it turned up in the possession of Geoffrey de Charny. It does not seem unreasonable to conjecture some kind of family relationship — the spelling of the name was irrelevant in those days — whereby Geoffrey de Charny came into possession of the Shroud; it would also explain his family's reluctance to explain where the Shroud came from — de Charny would not wish to be accused of heresy as a Templar.

Whilst this conjectural history of the Shroud is pretty convincing, it must be emphasised that it works from the premise that the Shroud *is* genuine; if one wishes to look at it another way, the theory also gives us a fair amount of evidence to suppose that the Shroud could be a copy of the Mandylion — if the scientific evidence didn't seem to be against the Shroud's having been the work of an artist.

## The question of authenticity

When talking of the Shroud's authenticity, it must be emphasised that we are talking about whether or not it originates from the first century A.D., and whether or not the image was 'made by hands'. Science will never be able to prove or disprove conclusively whether it was Christ's body that caused the image to be formed or not; that must be left to the speculation of religion.

There are, however, many scientific findings which indicate that the Shroud is not fourteenth century artistic forgery: the lack of pigments found, the absence of any penetration of the fibres or the spaces between fibres, the consistency of the weaving and the cotton particles with the Middle Eastern area around the first century, the anatomical evidence of the crucifixion, the pollen samples from Middle Eastern areas, notably around the Dead Sea, as well as from Constantinople and Europe. These pollen samples also substantiate Wilson's theory that the Shroud spent some time in Edessa, which is in the region of the Anatolian steppe.

There is also the question of the means of image formation, the aspect of the Shroud which scientists study with the most interest; even if it was man-made, we still have no idea of the process.

If Ian Wilson's theory of the history of the Shroud is accepted, this would diminish scepticism about its authenticity on the ground of its mysterious appearance. We would therefore seem to be left with only one large stumbling-block to acceptance of the Shroud as an authentic image of a resurrection: the fact that it's never been seen before or since, and without explanation of the process many people are unable to accept it as a miracle.

## How was the image formed?

As stated, this question arouses the main curiosity of scientists; what force could possibly have caused the formation of this negative, three-dimensional image? The word 'force' is used purposely, since it seems more and more apparent from modern research that the image was not caused by direct bodily contact with the Shroud. Attempts at reproducing this 'contact' process with bodily oils, unguents, etc, have failed to produce anything looking remotely like the image on the Shroud. The lack of penetration of the 'blood' or the image into the fibres supports this, as does the three-dimensional information carried by the image.

A more promising suggestion is that the image is some kind of scorch, the colour being the sepia of the first stage of the oxidisation process before actual burning. A cloth placed over a heated brass ornament produced an image far more like that of the Shroud than any other experiment yet tried, and spectroscopic laboratory analysis bears this theory out.

What, however, could have caused a dead body to produce a radiance or force sufficient to scorch cloth, acting in so controlled a manner and over so short a period that it dissolved and fused blood flows on to the cloth as well as creating the perfect impression of the body, yet without actually burning the cloth? Some kind of very swift thermonuclear flash, acting in an upward and downward direction with no diffusion, is the answer that has leapt to the minds of many scientists, though they are no nearer to explaining how this could be possible than they were before. However, as experience at Hiroshima has shown, such powerful blasts can cause prints of shadows cast by the light of the blast to be imprinted on buildings, etc. There are even photographs to prove this.

So although scientists now have better access to investigation of the Shroud than ever before, none of their work has yet been conclusive. Research has indicated that the Shroud is unlikely to be an artist's forgery, yet scientists still cannot explain how the image got on to the linen, either naturally or by the hand of man. For this reason the results of the analysis of the scientific tests of 1978 are eagerly awaited to provide more evidence to help unravel the mystery of the Holy Shroud of Turin. ●

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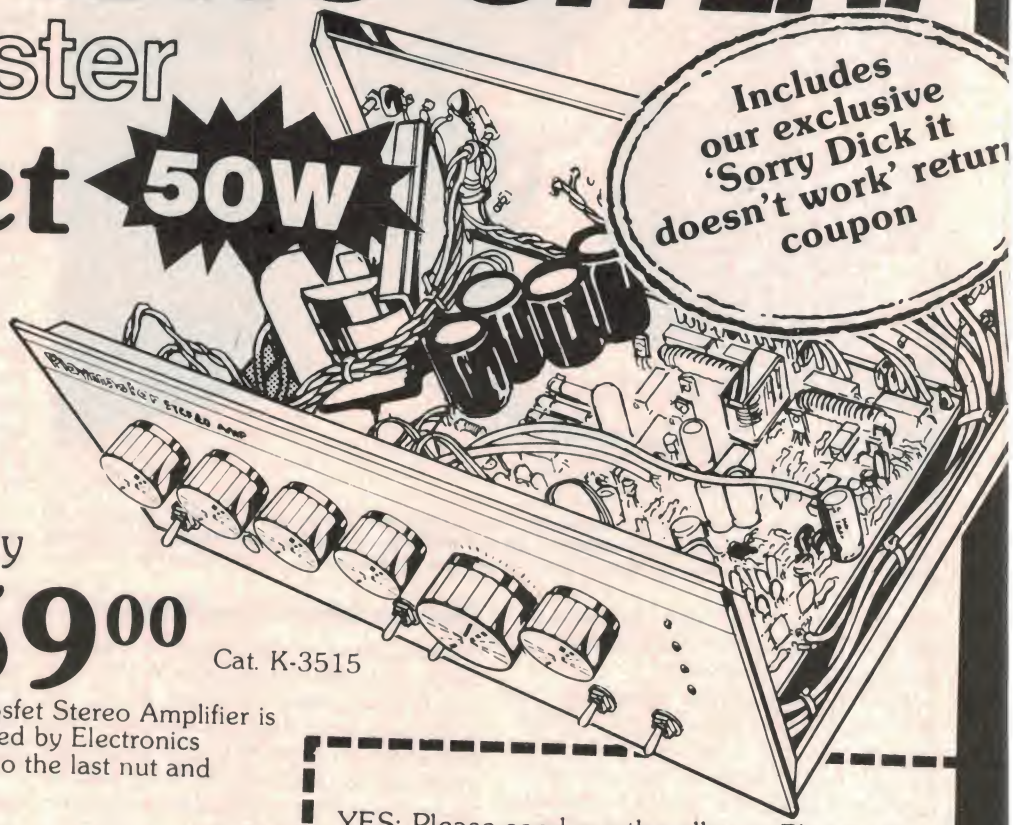

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AP 3477

# Scientific examination of the Holy Shroud

Few archaeological artefacts or religious relics have attracted such intense cross-disciplinary scientific interest as this. Some 50 scientists and technicians spent a week in October 1978 making an enormous variety of measurements and taking samples. Some of the results of this mammoth effort began to appear last year. This is the first review article of the researches yet published. Is the Shroud authentic, or a fake? The evidence is amazing!

**Brian Dance**

THE HOLY SHROUD of Turin is not only one of the greatest religious mysteries of all time, but this ancient treasure is also posing very intractable scientific problems. These problems are puzzling many of the world's top scientists, who are still unable to explain exactly how such an image could have been produced. Even if the image had no religious significance, the way in which it has been formed would justify extensive study in itself.

The Holy Shroud of Turin is an old, rather yellow piece of linen cloth about 4.3 m long by 1.1 m wide. It bears a faint image of a naked man of about 1.8 m (5'11") in height. One of its strangest features is that the highlights and shadows in this image are reversed as in a photographic negative. The image shows brownish-red stains, these being in the form of a positive image in the regions of the wrists and feet where crucifixion wounds would have been made, and also has stains resembling blood around the head and in the side of the chest, etc. Even stranger is the fact that the image (at least in the face and hands) contains three-dimensional information; scientists are using the computers designed to process the images of distant planets to try to unravel the mysteries of the image on the Shroud.

The Turin Shroud has been a subject of controversy for centuries. Many scientific results tend to support its authenticity, but even as I write this, I hear a report on British radio that Dr. Walter McCrone has found particles of fine grain oxides in samples taken from the Shroud on sticky tape in 1978, which could have arisen from paint used by a mediaeval image faker. In addition, Dr. McCrone was stated to have found 'tempera' in the specimens — a material used in ancient paints. However, the results of the recent work seem to show conclusively that the image could not be a painted one.

(Left to right) Dr. Ray Rogers, Dr. John Jackson (American scientific team) and Professor Giovanni Riggi (Turin, Italy) take their first glimpse of the underside of the Shroud as Professor Luigi Gonella (representing the Archbishop of Turin) looks on. *© 1978 Barrie M. Schwortz*

## The image

The brownish-coloured image on the Shroud is that of a nude man probably aged between 30 and 40 years. One half of the Shroud carries an image of the front of the man and the other half of the back, so it seems that the body was laid with the feet at one end of the Shroud and the head at the middle; the other half was then folded over the body.

It was not until 1898 that the image was discovered to be a negative one. Secondo Pia had taken a photograph of the image and realised that the image on his photographic plate was really the positive and the Shroud image the negative. Who would wish to fake the image of a man as a negative (before photography was known)?

Paintings of crucifixions show nails driven through the hands of the crucified person, but the French surgeon Dr. Pierre Barbet experimented with dead people and found that nails in the palms will not support the weight of the body. He found that a nail in the forearm would do, but it was not until 1968 that the skeleton of a crucified man was found with marks on the arm showing a nail had been driven through the arm. Thus both medical and archaeological evidence indicates that the crucifixion marks on the wrists of the Shroud image are in the correct places, whereas a faker would have put the nails in the centre of the palm as the painters have done.

The apparent absence of thumbs in the Shroud image has been attributed to ▶

the nails driven through the wrists piercing the median nerves and producing an automatic contraction of the thumbs.

Little more scientific knowledge about the Shroud came to light until 1973, when it was found that the image on the cloth is quite superficial, having a depth of only a few micrometres[3] on the top of the linen threads. The image is not visible under the microscope inside a thread.

If some form of paint had been used to produce the image on the Shroud, the medium used would have darkened more rapidly than the remainder of the cloth[3], but no discolouration of this type is visible. One would also expect the paint medium to affect the flow of water used during the fire through the image region, but this is not found[3]. Thus if the image had been painted on the linen, it seems this painting must have occurred after the fire of 1532 and this is known to be contrary to fact.

The image on the Shroud when viewed on the VP-8 Image Analyser. (Courtesy JPL).

## Pollen samples

In the 1973 tests sticky tape was pressed on the Shroud to remove dust and any other particles which adhered to it. It was found that pollen grains were present not only from plants found in France and Italy, but also from those found in Palestine and in saline regions such as the Dead Sea. This may give some general indication that the Shroud had at one time been in the region of Palestine, but it cannot prove this, since pollen can be carried very long distances by various means (birds, winds, etc).

## Three dimensions

In 1977 two scientists of the US Air Force Academy, John P. Jackson and Eric J. Jumper, reported that they had found that the density (or darkness) of the image varies directly with the distance that the corresponding part of the body would have been from the Shroud which covered it[4-6]. Microdensitometer measurements have been correlated with the estimated body-cloth distance and these suggest that the image contains three-dimensional information. The darkest parts of the image, such as the nose, would have been closest to the Shroud.

Jumper and Jackson felt that the image must therefore have been formed at a distance and not by close contact. They carried out measurements on the cloth-to-body distances using a man of similar build in a similar pose with the aid of stereometric photography[6]. Their photographs were processed with a complex image analyser instrument which had been designed to convert variations of image intensity into distance. They found that the Shroud contains three-dimensional information and used a computer to reconstruct a three-dimensional model of the image. This clearly showed that the image of the Shroud is quite unlike any normal photographic image. The smallest feature of the image which can be resolved is 5 mm[7].

Our discussion so far has been a brief account of the work on the Shroud up to 1978, although many details have been omitted for brevity. For example, we have not considered the attempts made to produce shroud-like images by scorching linen. Neither have we considered the ancient practice of washing cloth in a solution known as 'struthium' (containing the soap weed *Saponaria officinalis*) which not only softens the cloth, but which is toxic to simple living organisms and which therefore inhibits the growth of moulds, mildew, etc.; such a wash may have given the Shroud its fluorescence[3].

## STURP

It was largely through the interest created by the three-dimensional image work in the USA that a team of 32 specialist US scientists was formed who sought and obtained permission to carry out by far the most thorough scientific investigation ever made on the Shroud.

Some of the scientists call themselves 'sindologists', this name being derived from the Italian word 'sindone' (shroud). They are a largely self-appointed, independent, non-profit-making group of scientists and assistants and do not work under the auspices of any other body. The name STURP (Shroud of Turin Research Project Incorporated) has been adopted by this group. Previous investigators have been mainly selected by the Archbishop of Turin.

STURP's scientific proposals were submitted to the Archbishop of Turin (keeper of the Shroud) and to Centro Internazionale di Sindonologia in September 1977, and to Umberto II, a former King of Italy and the legal owner of the Shroud; all gave their approval.

The workers were divided into teams to cover the various types of investigations. They worked out their testing schedule and collected and constructed specialised instruments ready for their trip. Basically they were to examine the Shroud with electromagnetic radiation of all wavelengths from the mid-infrared through the visible and ultraviolet to the X-ray region.

A special test frame was constructed to support the Shroud and its backing cloth, which had been sewn to it after the fire of 1532. The frame could be rotated from the vertical to the horizontal[9] and magnetic strips were used to hold the Shroud. Panels 200 mm wide could be removed from the middle part of the frame to provide optimum access for some X-ray investigations.

## Operation STURP

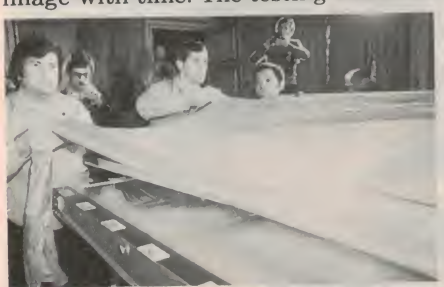
The Shroud was placed on public display in October 1978 to commemorate the 400th anniversary of its arrival in Turin, this being the first public display for 45 years. At the end of this display on Sunday, October 8 1978, the Shroud was removed from its nitrogen-filled case to

A photographic negative of the Shroud facial area shows considerable detail. The image contains three-dimensional information — darkness (brightness here) varying with apparent distance from body to cloth. The most striking evidence of this was produced by Jackson and Jumper, seen in the picture at left, using image analysing equipment at the California Institute of Technology's Jet Propulsion Laboratory.



the nearby Visiting Princes' rooms of the Palace of the House of Savoy, where it was given over to the scientists for five days.

The main objects of the investigations were to try to establish the nature of the image on the Shroud, to characterise the image spectrally over a wide range of wavelengths, to investigate the nature of the stains on the Shroud and in particular to try to ascertain if they are due to blood, and to study the manufacturing technique of the cloth so as to check whether it is likely to have been woven about the time of Christ. It was also hoped to be able to make recommendations about the optimum conditions of storage to prevent degradation of the image with time. The testing had to be non-destructive and could only be carried out during this one period.



Transferring the Shroud from its display support board to the Shroud support table. Pictured left to right: Don Janney, Tom D'Muhala, Mark Evans, John Jackson, Don Devan. In background: Ricardo Bissi (Italian team photographer).



The team of investigators, almost all from the USA, has agreed to publish all their findings and some of their papers have already appeared. The Church has agreed that it will not interfere with these publications. As the scientists have been working in their spare time, there has inevitably been some delay in the publication of their results. A 'complete' report may appear by 1982.

## Scientific work

The work of the scientists included looking for fluorescence under X-ray and ultraviolet irradiation. X-ray fluorescence provides data on the elements present in various parts of the Shroud. In the X-radiography work, low-energy X-rays were passed through the Shroud and were detected by an X-ray film placed at the back of the Shroud. The films were manually processed in a nearby darkroom and were given a preliminary visual examination so that any necessary changes could be made in the exposure of the subsequent films[9].

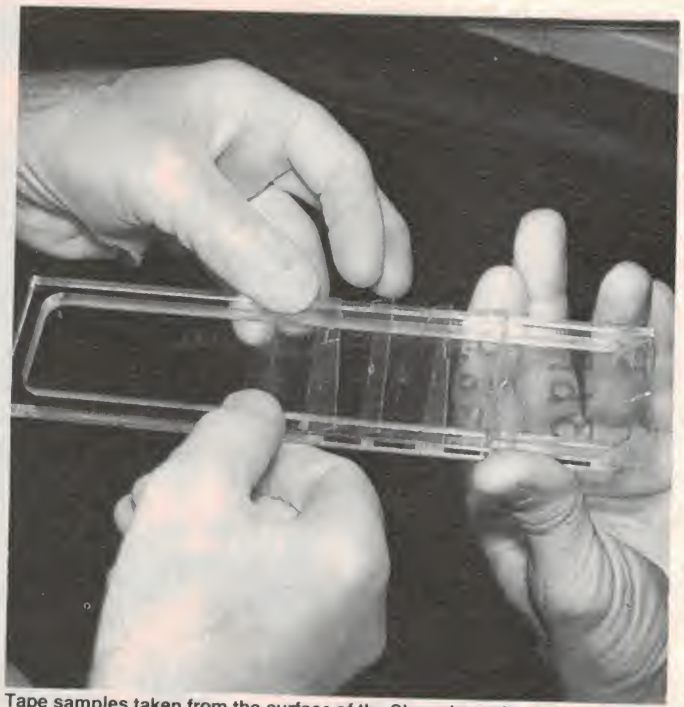
In the visible region an extensive series of photographs was made with red, green and blue filters for colour separation so that colour mosaics of the whole surface of the cloth could be built up at reductions of 5.6:1 and 22:1[9]. The importance of this visual light photographic work becomes obvious if one remembers that the computer work on the image, including three dimensional image work, was carried out with photographs made in 1931[10]. The filters were chosen by Sam Pellicori, a physicist employed at the Hughes Aircraft Company's Santa Barbara Research Centre, California, so as to bring out the slight colour differences between various parts of the Shroud. The images underwent further processing by computer programs developed at the Jet Propulsion Laboratory's Image Processing Laboratory for Planetary Studies, which have been especially designed to bring out every possible piece of detail in the images returned by spacecraft from distant planets. The raw images returned by such spacecraft often show little contrast — rather like the Shroud. Over 500 photographs were taken at various wavelengths.

In other work ultraviolet transmitting filters were used for contrast enhancement. Another series of photographs was taken in which the visible spectrum was divided into 10 nm intervals by a series of filters[9]. The Shroud was also examined in infrared radiation to ascertain if any new features became visible, since chemicals containing certain groups of atoms may be identified in this region. Infrared thermographic techniques were employed, since together with micro-Raman spectra these are considered to be the most likely methods for identifying blood components and certain types of burial substances mentioned in the Scriptures[8].

Minute particles of fibre, pollen, dust, etc. were removed by means of specially prepared adhesive tapes and also by means of a suction device. In the case of the tape, both the adhesive and the tape were made of pure hydrocarbons so that the Shroud was not contaminated — indeed, the scientists wore white gloves when handling the Shroud. The adhesive tape was applied to the Shroud with a specially designed roller; after it had been removed each tape was attached to a labelled microscope slide and placed in a box which was later sealed.

The particles of material removed on the tapes were examined by visual microscopy and by the micro-Raman method. Further work on these particles involved electron spin resonance, electron microscopy, ion microprobe techniques and the scanning electron microscope[9]. It is hoped that scanning electron microscope images at magnifi- ▶

(Left to right) Chemist Ray Rogers (American scientific team) looks on as Swiss criminologist Dr. Max Frei takes a tape sample of the Shroud. Rogers took 36 tape samples for the American team. © 1978 Barrie M. Schwortz



Tape samples taken from the surface of the Shroud are placed on specially sterilised glass plates. © 1978 Barrie M. Schwortz

cations of up to 10 000 times will provide data of the image depth and sharpness at different points on the Shroud and this may help us to produce a satisfactory theory of the image formation mechanism[8].

Even the back surface of the Shroud was examined after parts of the backing cloth (stitched on in the 16th Century) had been loosened. An Italian biologist, Giovanni Riggi, employed fibre optics to photograph the back surfaces, and he also collected particles from it[6]. A few extra threads were taken for later examination.

Now that we have looked generally at the scope of the 1978 investigations, we will consider specific items of the work in more detail, together with the results already published.

## X-ray fluorescence

The main aim of the X-ray fluorescence experiment was to estimate the variations in the concentration of the elements in different areas of the Shroud containing 'blood' stains, other parts of the image, the background cloth, the scorch areas and the patches[11]. Elements with atomic numbers exceeding 16 could be detected with the equipment used.

An X-ray tube operating at 50 pkV and 20 mA and shielded in lead (Figure 1) had its beam directed on to a tin target within the shielding[11]. This produced the 25.5 keV K-alpha radiation, a 12 um thick silver foil located over the outlet removing the K-beta radiation from the tin target. Thus this system produced a beam containing almost monochromatic 25.5 keV X-rays which were allowed to strike the vertical surface of the Shroud at about 45°.

The fluorescent X-rays from the Shroud were detected by a silicon (lithium) semiconductor detector shielded with lead so that an area of 1.3 $cm^2$ of the Shroud surface was examined at any one time. The pulses from the detector were amplified and fed to a pulse-height-analyser having 512 channels. Each spectrum was transferred to a digital cassette for subsequent analysis.

The X-ray fluorescence workers collected a total of 37 spectra (including background, calibration and Shroud data) and made further calibration measurements after their return to Los Alamos[11]. The most obvious feature in all of their spectra was a Compton peak formed by the scattering of 25.5 keV X-rays by electrons. However, one can detect elements present in the Shroud by the presence of peaks in the photon energy spectra at less than 20 keV; these peaks are due to the K-alpha radiation of the elements (fluorescence).

A prominent peak due to iron at 6.4 keV (with a smaller peak at 7.0 keV due to its K-beta X-rays) was found in

Scientists eagerly examine the underside of the Shroud, seen for the first time in 400 years. This is the first photograph taken of the underside of the Shroud. © 1978 Barrie M. Schwortz

the 'blood' stained regions and a much smaller iron peak in other areas of the Shroud (Figure 2). This does not prove that the 'blood' stained areas contain blood, since a material such as jeweller's rouge ($Fe_2O_3$) could have been used as an image-colouring agent. A quantitative comparison between whole blood, rouge stains and the Shroud results was made. Calcium and strontium were found, but the workers suggested that these may have arisen from dust carried from the marble and limestone regions of northern Italy. The absence of heavier atoms, as far as could be detected with the equipment used, indicates that pigments or dyes containing such elements could be present only in small amounts.

The paper concludes by suggesting that radioisotope sources have advantages over an X-ray tube source for any future X-ray fluorescence study[11]. It is feasible for a future study to look for potassium in the 'blood' stains with equipment of adequate sensitivity, since blood contains appreciable amounts of this element as well as iron.

## UV work

The ultraviolet-visible reflectance and fluorescence spectra from the Shroud have been investigated in detail by the husband-and-wife team of Roger and Marion Gilbert, who state[12] that their measurements were performed as an aid to later analysis of the substances making up the various stains on the cloth and to a possible determination of the manufacturing techniques of the cloth. They took fluorescence and absolute reflectance spectra on areas of the Shroud not containing markings for possible comparison with other cloth samples. They also recorded fluorescence and relative reflectance spectra of the image, scorched and bloodstained areas, the reflectance being relative to clear areas.

These workers used a 150 W xenon lamp or a 200 W mercury arc lamp with a 1200 line/mm diffraction grating monochromator to provide a beam of 5 nm bandwidth, which illuminated a 6 mm by 3 mm area of the Shroud at an incident angle of 45°; this angle was chosen rather than 0° in order to reduce the apparent spaces between the threads of the cloth and hence to reduce the contribution from the backing cloth. The beam optics need not concern us. The detection channel was similar to the source channel and contained a second monochromator with an 8 nm bandwidth. The output from this second monochromator was directed onto the photocathode of a photomultiplier tube.

A voltage proportional to the wavelength of the second monochromator was fed to the x-axis input of a pen recorder and the amplified signal from the photomultiplier tube to the y-axis input. Twenty six scans were made over the 250 nm to 750 nm band in the reflectance measurements and a scan of magnesium oxide was made; the reflectivity of the latter was assumed to be unity. The xenon lamp was used for these reflectance measurements.

The mercury arc lamp was used in the fluorescence measurements with the source monochromator set at 365 nm and an ultraviolet-transmitting, visible-absorbing filter after the monochromator to reduce stray visible light. An ultraviolet-absorbing filter was placed in the detection channel and the monochromator was continuously scanned from 390 nm to 700 nm.

The relative spectral reflectance of four areas of the Shroud image is shown in Figure 3 and the spectral fluorescence of four similar areas in Figure 4[12]. It can be seen that the lower the reflectance of an area, the lower the fluorescence. At lower fluorescence levels, the peak moves towards longer wavelengths.

These workers noted that the image (without magnification) seems to have the same sepia colouring as the lightest of scorch marks and that the image colour does not seem to come from a particular matter. The image is extremely faint under backlighting, whereas the bloodstains then stand out as dark reddish-brown spots. ▶

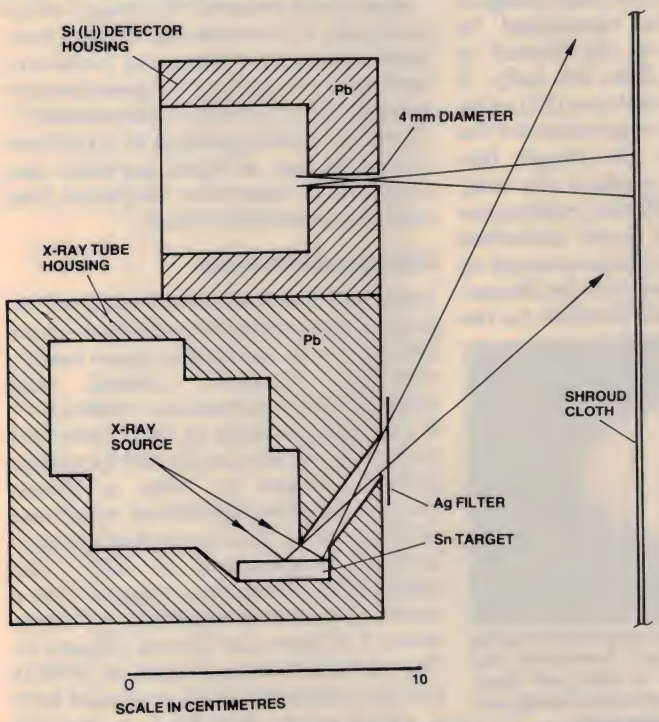



*Figure 1.* **The apparatus used for the X-ray work. (Reproduced from reference 11).**

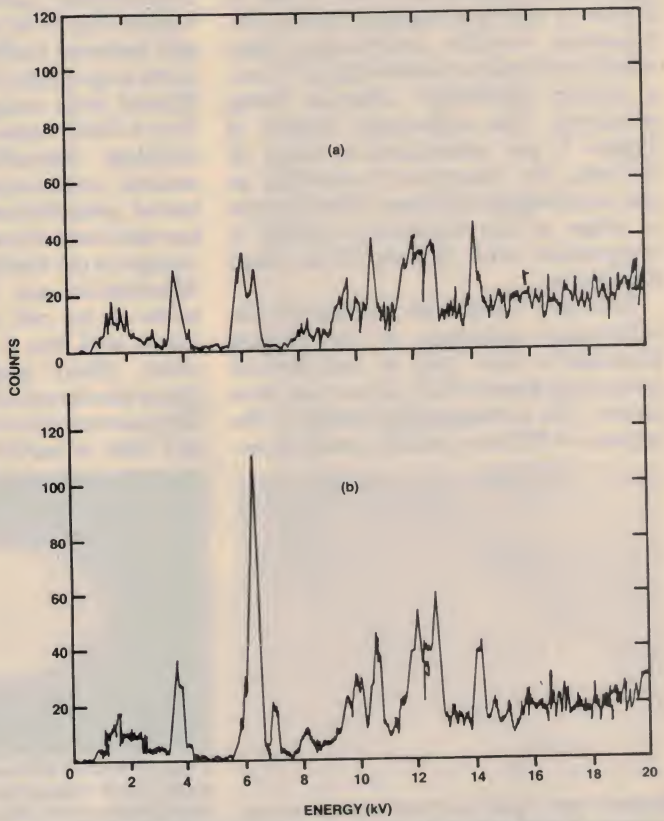



*Figure 2.* **(a) X-ray fluorescence spectrum; (b) similar spectrum taken over the side wound 'blood' region. Note the higher peak at 6.4 keV. (Reproduced from reference 11.)**

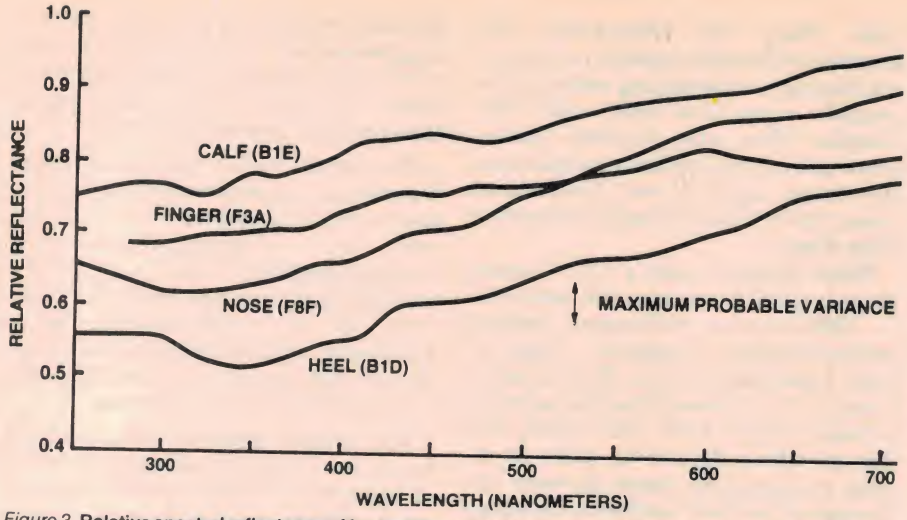



*Figure 3.* **Relative spectral reflectance of four regions of the body image. (Reproduced from reference 12.)**

The body image areas seem to have the same spectral reflectance properties as those of the scorched areas together with similar fluorescence characteristics. The stains seem to quench the fluorescence of the cloth and to exhibit a low-level fluorescence of their own in the 600-700 nm region.

## Further spectral work

Further work on the spectral properties of the Shroud, mainly in the visible region, has been described in a paper by S.F. Pellicori[7]. His results using a 'quick look' spectrometer are shown in Figure 5; this spectrometer used a continuously variable interference filter wheel to provide a bandwidth of 17 nm, a silicon photodiode detector being employed. The reflectance curves of Figure 5 are normalised to unity at 700 nm, the absorption increasing as the wavelength decreases. The changes in slope of the bloodstains makes a comparison with human blood more definitive.

Pellicori[7] has also compared the reflectance spectrum of the Shroud bloodstains with that of four-day-old laboratory blood which, in one case, was baked. The corresponding bands in the regions of 550 nm and 625 nm have enabled him to say that there is sufficient correlation to decide that the material on the Shroud is blood.

The relative spectral responses of substances that may once have been in contact with the Shroud have been examined before and after baking in air for five hours at 150°C; the baking simulates aging of the cloth and produces a colour similar to that of the clear areas of the Shroud[7]. This colour is due to the formation of double bonds in the cellulose, which results in increasing absorption at shorter wavelengths. Experiments have shown that an invisible deposit of perspiration plus skin oils becomes visible on baking and displays a spectrum closely resembling the Shroud body image. It was concluded that a likely cause of the body image is cellulose degradation stimulated by natural substances on the Shroud or burial preparations from the body. It has also been shown that iron (III) oxide (rouge) is not wholly responsible for the 'bloodstains' nor for the image; this oxide is too red to produce the body image and has a different reflectance curve. Many people have remarked about the decrease in image contrast as the observer comes nearer to the Shroud and this is partly attributable to the increased contribution of scattered light into the cone of vision.

In order to preserve the image, which is already of low-contrast, storage in an inert atmosphere (nitrogen) containing some water vapour at temperatures not exceeding 25° has been recommended[7]. Physical handling should be minimised to reduce loss of blood particles, and exposure to ultraviolet radiation from sunlight should be avoided.

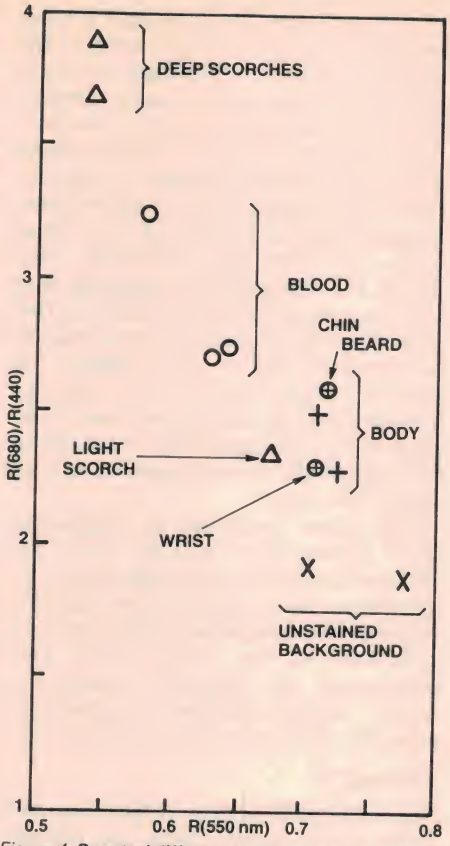
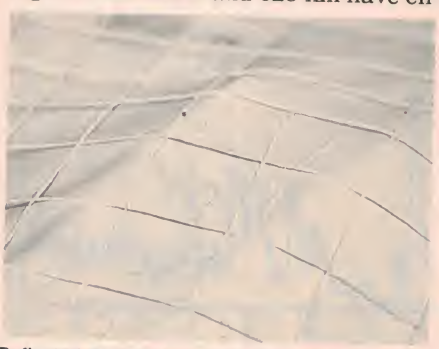



*Figure 4.* **Spectral differences of various details on the Shroud are intensified by taking the ratio of widely separated reflectances and normalising to the absolute R at 550 nm. Notice the grouping by stain type, and that the darker the feature is, the redder it is. The body image points 'Beard' and 'Wrist' contain minute traces of blood.**



**Reflected light close-up of #3 bloodstain on the forehead of the frontal image, with a 6 cm grid placed over that area of the Shroud for size reference.** *© 1978 Barrie M. Schwortz*

**#3 bloodstain of the frontal image of the Shroud viewed with transmitted light. This is the first photograph of the Shroud of Turin with transmitted light, showing the comparative density of a bloodstained area versus image area.**

*© 1978 Barrie M. Schwortz*

## Infrared studies

Infrared reflectance spectroscopy of the Shroud was undertaken in the 3 - 5 um and the 8 - 14 um bands, where readily available detectors coincide with atmospheric transmission windows[13]. A black-body source at 980°C provided radiation, which was focused by sodium chloride lenses to form a 20 mm diameter spot on the Shroud, which was 400 mm away, thus producing an equilibrium temperature of 59°C. The reflected radiation was detected with a mercury-cadmium-telluride detector about 2 m from the Shroud (Figure 6). The radiation was chopped at 500 Hz and the reflected signal processed with a synchronous amplifier to provide background rejection.

The spectral similarities of most of the features observed rendered the results somewhat inconclusive. The Shroud bloodstained areas showed different spectra from known bloodstains both in the shorter (Figure 7) and longer wavelength (Figure 8) bands. It has been suggested that these differences are due to surface effects rather than the chemical composition of the materials[13].

The same workers carried out imaging experiments in the same two wavelength bands using two 1500 W photographic floodlamps to illuminate the area[13]. No image contrast was observable without this illumination, showing that an increase in the temperature above that of the background was required; without this the differences in emissivity were below the limit of sensitivity of the cameras. Good contrast was found in the 8 to 14 um band, but no features could be found in ▶

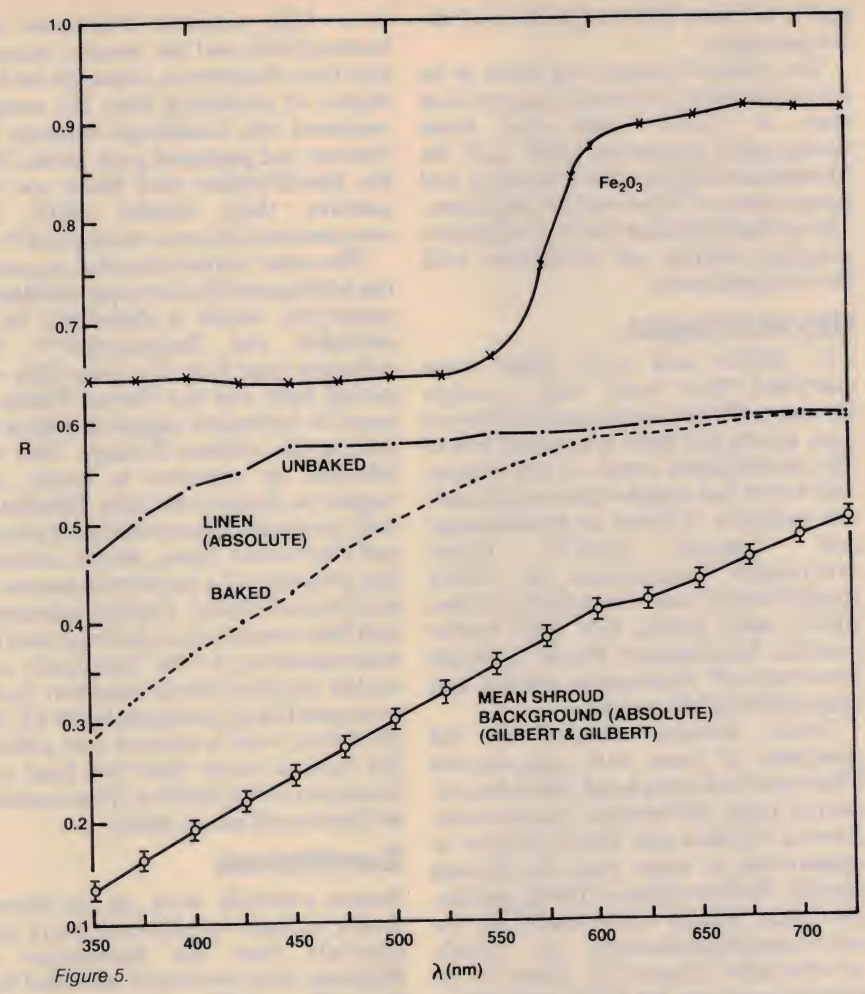



*Figure 5.* **Shroud background linen and modern linen artificially aged by baking. Reflectance of iron oxide to be compared with body image (Figure 7). If $Fe_2O_3$ were present in a high enough concentration to make up a visible image, its reflectance curve would be quite different from the Shroud's image.**

*Figure 6.* **Comparison between Shroud blood spectrum and laboratory blood artificially aged by baking.**

*Figure 7.* **Laboratory simulations of body image spectral reflectance characteristics produced by accelerated aging, and Shroud body image included for comparison. $P_1$ and $P_3$ are skin oil plus perspiration.**

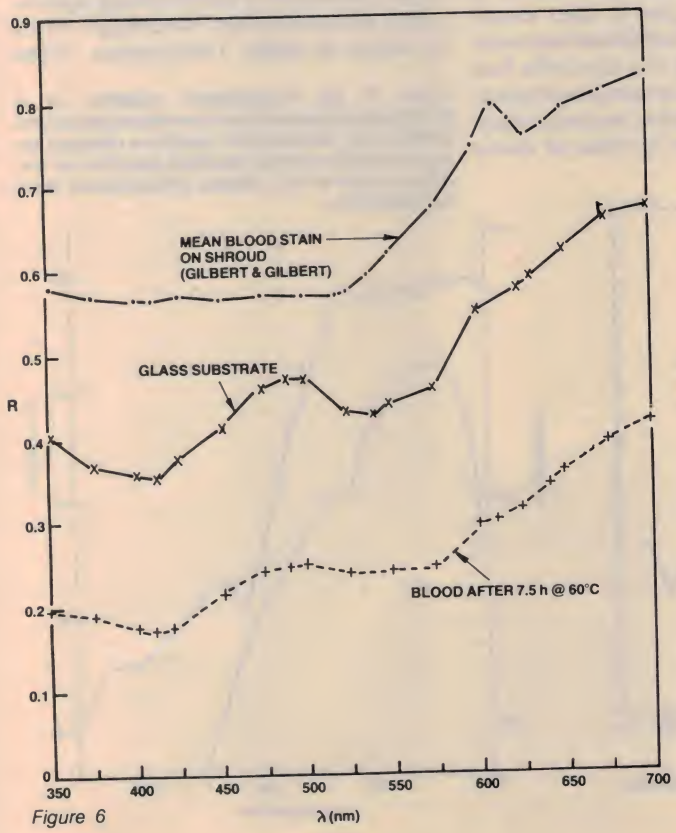



*Figure 6*

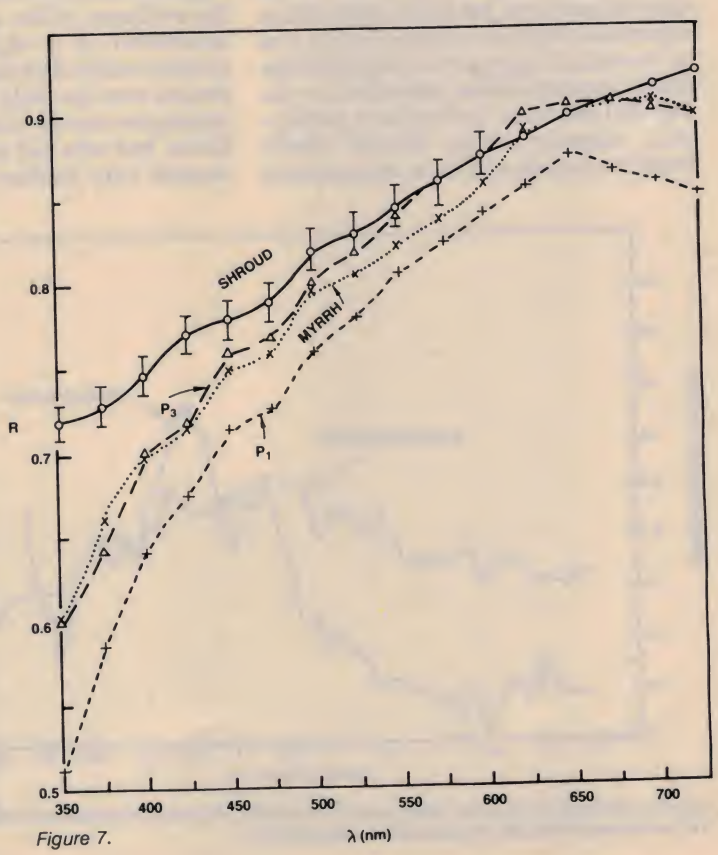



*Figure 7.*

the 3 to 5 um band regardless of the illumination.

The infrared image was found to be approximately a reversed image of that seen in visible light, the linen background appearing black and the bloodstains bright, with the scorch and image areas of intermediate brightness. The authors felt that the thermographic imaging results are consistent with their expectations.

## Blood on tapes

J.H. Heller and A.D. Adler have described their work with a single 25 mm x 75 mm specimen of adhesive tape which had been pressed on one of the bloodstained areas of the Shroud and which has enabled them to identify the presence of blood by spectroscopic and chemical tests[14]. Under microscopic examination at 1000X magnification, some hundreds of linen fibrils were found, less than twelve possible bloodstained fibrils, a single brownish-red translucent crystal and other debris of the centuries.

These workers stained an old specimen of linen with one-year-old blood and took samples of this using adhesive tape. Microscopic examination showed crystals and fibrils similar in appearance to those from the Shroud sample. Both the Shroud fibrils and the simulated fibrils were examined by micro-spectrophotometry at visible wavelengths (Figure 9). There is no specific spectrum for blood, since much depends on its exact chemical state and on its state of aggregation, but all of the fibrils showed intense absorption in the 400-450 nm band, indicating a porphyrinic substance. The Shroud fibrils would be expected to show the spectrum of a fully oxidised denatured methaemoglobin and the results indicated this type of spectrum, although the high degree of scattering from the samples rendered the bandshape features less distinct and produced peak shifts. Thus the identification with blood was less positive than desired when this measurement alone is considered[14].

The same workers decided to convert the heme group in the suspected blood to porphyrin, which is detectable by its excitable red fluorescence[14]. The adhesive tape from the glass slide was peeled back and the Shroud fibrils exposed to hydrazine vapour to reduce the iron to the valency II stage. This was followed by exposure to formic acid vapour to displace the iron. Irradiation with longwave ultraviolet then showed red fluorescent spots, which indicated the presence of a porphyrin species on the Shroud fibrils. Vapour techniques had been employed in the hope that the microspectrum of the chemically converted material would establish that it was specifically protoporphyrin IX, but the formic acid treatment had affected the tape so much that this final confirmation of the identity of the material as blood could not be made.

## Conclusions

Recent scientific work on the Shroud seems to have established fairly conclusively that the bloodstains do originate from real blood, provided that the evidence of the various workers is considered as a whole. It also seems almost certain that the Shroud was once draped over the body of a man who had undergone not only the tortures of crucifixion, but who had also received other wounds very similar to those of Jesus Christ as described in the Gospels (the side wound, the crown of thorns and the beating).

The conclusions on the mechanism of image formation seem less definite. The suggestion of Pellicori that the image was formed by perspiration and oils accelerating the normal degradation and darkening of the cellulose of the cloth seems to be the most promising. It is supported by laboratory evidence in which darkening of cellulose cloths was speeded by baking; body oils, sweat and olive oil (the latter is found in myrrh and aloes used in the burial oils of ancient Palestine) were used in these experiments[15]. The images formed in some hours and had some characteristics of the Shroud image when viewed microscopically.

Pellicori's hypothesis suggests the Shroud image was formed by skin contact. Some say this could not explain the three-dimensional effect, but Pellicori[15] feels we do not yet have enough understanding of the image transfer mechanism to answer this point. Not all scientists agree with Pellicori's suggestions. Early suggestions that the body image is light singeing of the cloth with a hot statue seem to be refuted by ultraviolet fluorescence studies, which show that the body image has a different fluorescence from the fire-scorched regions. As regards the work of McCrone (mentioned earlier), the STURP team made extensive tests to detect pigments or their binding agents, using microchemical techniques down to levels of under 1 microgram. None

*Figure 9.* **(a) Transmission spectrum of a brownish-red stained fibril from a blood area of the Shroud. (b) Transmission spectrum obtained by transformation of the reflection spectrum of the blood areas of the Shroud. (Reproduced from reference 14.)**

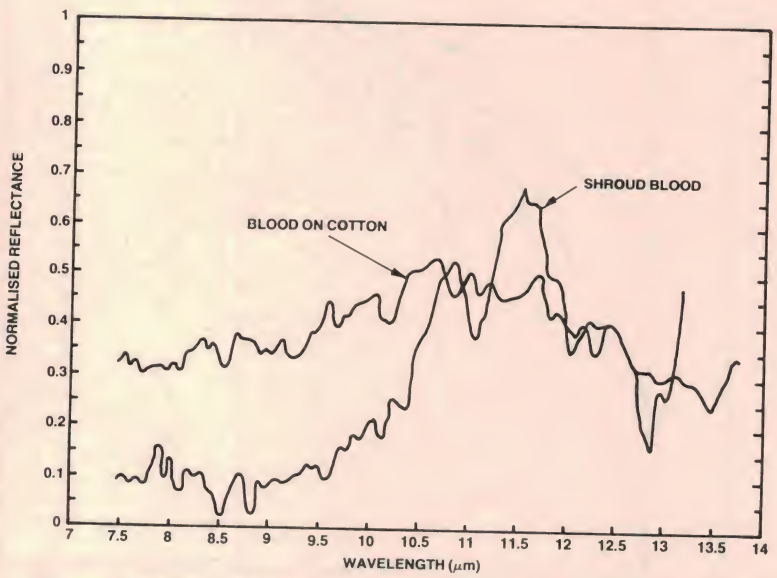



*Figure 8.* **Normalised spectral reflectance of blood-on-cotton and Shroud blood in the 8 to 14 μm infrared band. (Reproduced from reference 13.)**

were found and the traces of iron oxide revealed were not only invisible to the naked eye, but equally distributed throughout the image and non-image areas. How could they produce the image, in spite of McCrone's views?

The very detailed tests on the Shroud have given no indication that it could have been a fake — indeed, they indicate the opposite view. Although it might have been possible to prove the Shroud a fake, it seems science can never prove it is genuine, nor whom it covered — although no other suggestion than that it was the body of Jesus Christ seems to have been made. Science's main concern, however, is with 'how?' and not with 'whom?'.

Rev. David Sox (formerly Secretary of the British Society for the Turin Shroud) stated on British Radio that he is still not sure whether the Shroud is a fake. He has been pressing for its carbon dating for many years, but mentioned he no longer considers the Shroud to be important to his beliefs — especially as there is no indication in the Gospels that such a sign would be left for posterity.

## Carbon dating

Now that we have considered the published results of the work which has already been carried out on the Shroud, let us consider a long-proposed test which has not yet been performed. If the approximate age of the linen could be established, this might provide additional evidence as to whether the Shroud was made about the time of Christ. The obvious technique is the well-known one of carbon dating developed by Willard F. Libby.

Carbon-14 (a radioactive beta emitter) is formed in the upper atmosphere of the earth when neutrons formed by cosmic radiation interact with nitrogen nuclei. This carbon-14 has a long half-life (about 5730 years), so it becomes well-mixed with the non-radioactive carbon of the earth's atmosphere. Plants take in carbon dioxide from the air, so that the amount of carbon-14 per gram of carbon in a plant becomes equal to that in the air. This amount produces 15.3 radioactive disintegrations per minute per gram of carbon (dpm/g).

If a plant ceases to live, the carbon-14 it contains will continue to undergo radioactive decay but no new carbon-14 is taken in from the atmosphere. Thus after 5730 years the activity of the carbon-14 falls at $15.3/2 = 7.65$ dpm/g. Hence by measuring the activity of a specimen of carbon from a material such as linen which was once a living plant, one can estimate the time at which the plant ceased to be alive. An accuracy of the order of +/−150 years may be obtained for a specimen aged about 2000 years.

The reason this carbon-14 decay has not yet been used for dating the cloth of the Shroud is that an area of some hundreds of square cm[3] of the cloth would have been destroyed by such work through the use of the dating techniques available in the past. If the results were ambiguous, still more of the cloth would be needed. In any case experts feel it would be very surprising if the Shroud cloth has a date before the first century or after the fourth century[8], so one may well ask whether carbon dating can provide much useful information.

Recently carbon-14 dating techniques have been developed which should be able to give an estimate to within about 100 years using only a few milligrams of the cloth. American workers at the University of Rochester and at the Brookhaven National Laboratory have proposed dating by this new technique, which involves an accelerator and a sensitive mass spectrometer. The Shroud's owner, King Umberto, has already given his assent[3] and the matter is still under consideration by the Archbishop of Turin.

Material in the form of a few threads has already been removed for the purpose of carbon dating so that it will not be necessary to open the sealed Shroud container to obtain samples. It seems almost certain that dating will be carried out in the not too distant future with laboratories in the USA and England competing for the work on milligram samples. ●


### Acknowledgements

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**Other material**

*The Silent Witness*, Screenpro Films, 4 Meard St, London W1V 3HQ. A 55-minute film giving a good summary of what was known around 1977. Available as 16 mm film for rental or purchase and as video cassette.

*The Holy Shroud*, Don Bosco Films, 148 Main St, New York 10802. A 35 mm film strip or set of 35 mm slides.

*The 1978 Exposition of the Shroud of Turin*, Rev. F. Filas, Loyola University, Chicago. A documentary filmstrip with cassette commentary covering the 1978 public viewing and the scientific investigations. (From ACTA Foundation, 4848 N. Clark St, Chicago 60640.)

Photographs: Barrie Schwortz Studios, 310 E. Haley Street, Santa Barbara, California 93101.

# SOLAR PANELS — SPECIAL OFFER TO READERS OF ETI.

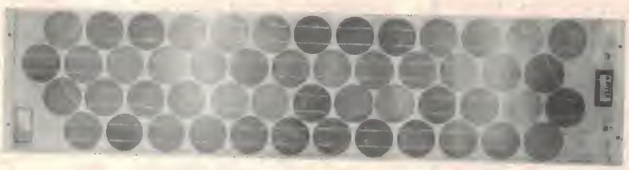
AMTEX ELECTRONICS, solar energy specialists, have available a number of *mil-spec*. solar panels that they are willing to offer to readers of ETI at a special price. These panels, type MB 4310, were manufactured by Sensor Technology (now called Photowatt International Inc.) for a military order and have the characteristics listed below:

## ELECTRICAL DATA

| | |
|---|---|
| Circuitry: | 51 cells of 75 mm dia. connected in series with dual, independent connections |
| Voltage at peak power: | 20 V |
| Current at peak power: | 1.2 A |
| Peak power output: | 24 Watt (Measured at a light intensity of 100 mW/cm$^2$ and 24°C) |
| Electrical insulation to substrate: | 2000 Vdc minimum |

## MECHANICAL DATA

| | |
|---|---|
| Nominal outside dimensions: | 1220 x 290 x 22 mm |
| Nominal weight: | 9 kg |
| Hail storm: | Hailstones up to 30 mm dia. |
| Wind loading: | 190 km/h |
| Storage temperature: | −40 to +80 °C |



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I enclose $ ..... plus $10 each freight and packing

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.....

..... Postcode .....

Cheque or money order .....

Signature .....

Please allow up to four weeks for delivery.

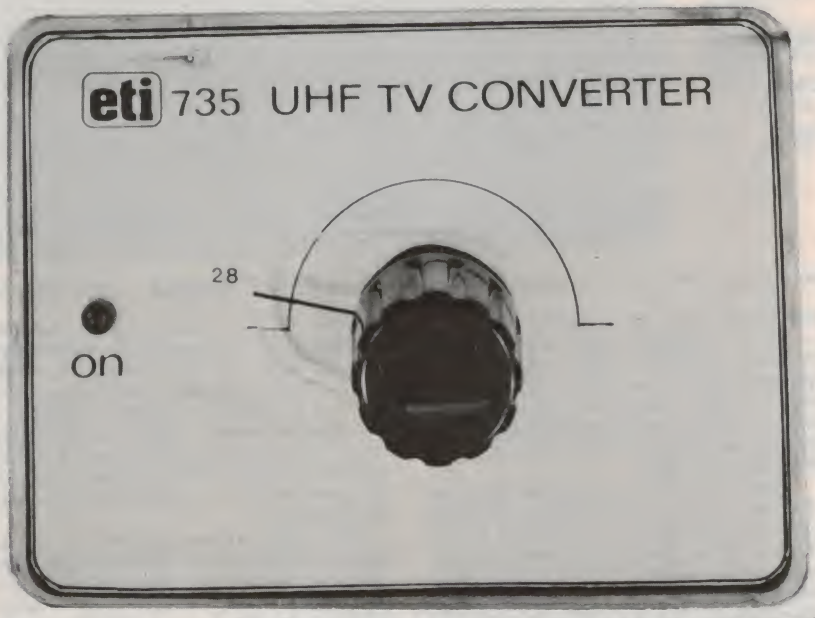
Project 735

# UHF to VHF TV converter

This project will convert TV station transmissions in the UHF band down to unoccupied channels in the VHF TV band. If your present TV set does not have a UHF tuner and you want to watch programmes on UHF, this project is for you.

**Phil Wait**

SINCE THE introduction of UHF TV services — first the translator services re-radiating the VHF station signals on UHF channels and then the multicultural service on channel 28 — the number of stations and service areas has grown at quite a rapid rate. It's no wonder that we have received many calls and letters from readers asking for projects to solve problems they had in trying to explore what the new services offered. We have already published an antenna design (ETI-728, March '81 issue) and a masthead amplifier (ETI-729, April '81 issue). However, these two projects only cater for those who own a TV receiver having a UHF tuner already built in. Judging from the deluge of requests following the antenna project in the March issue, it seems the biggest demand is for a UHF-to-VHF TV converter. We trust this project satisfies that demand.




Front panel view of the tuneable version of our UHF converter. Note there are two versions: tuneable and single channel.

## Design philosophy

The predominant design requirement for this project was *simple construction* and a *minimum of alignment*. We judged that most constructors tackling a project such as this would not be familiar with UHF circuit techniques. Consequently, the design had to be simple, yet provide good performance — at least as good as the front end of UHF TV tuners used in modern domestic TV sets. We feel those aims have been achieved.

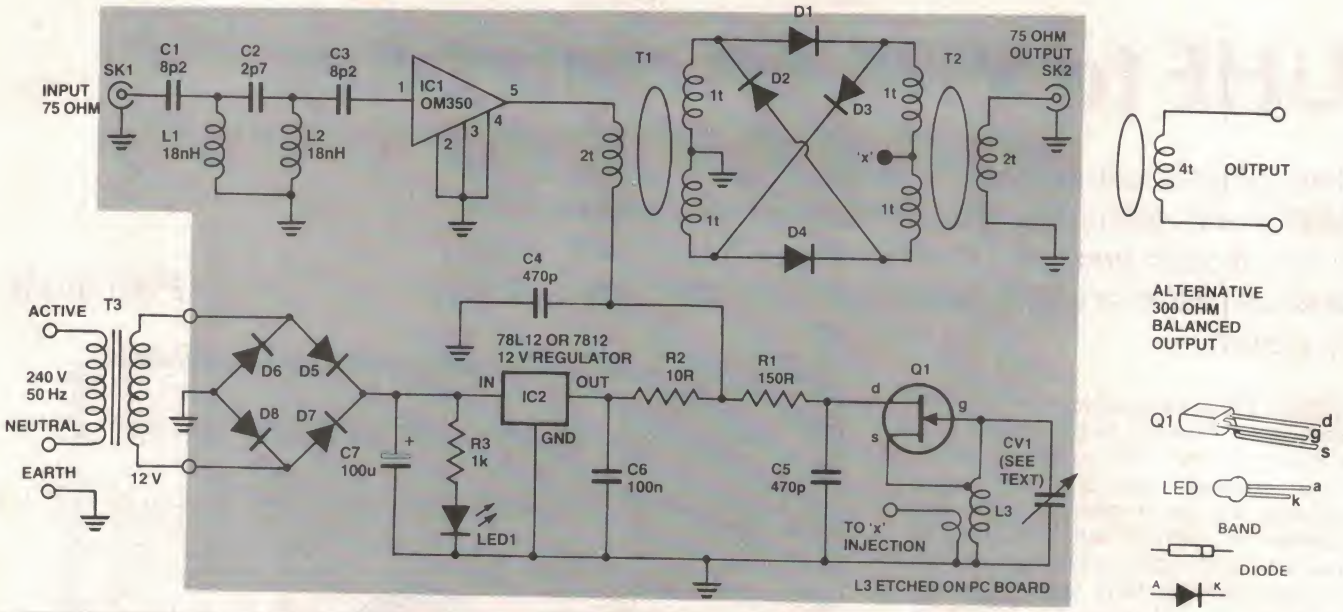
To reduce the requirement of alignment, there is only one adjustment — setting the local oscillator. That isn't even necessary in the tuneable version!

Before proceeding, we should explain that this project can be built in two versions: the *single channel* version and the *tuneable* version. Each has its advantages. If you only have a single UHF channel available in your area, and it's likely to remain that way for some time, then the single channel converter is the one you want. If you have several UHF channels available, then you can either make several single channel converters and set them up for the different channels, switching between converters, or you can make the tuneable version. If you only have one channel available currently and make a single channel converter, and then more channels become available later, the single channel converter is readily modified to the tuneable version.

The circuit arrangement is fairly conventional. An RF stage employing an OM350 hybrid wideband IC provides some 17-18 dB of gain before signal is applied to the mixer. A two-stage high-pass filter employed between the antenna and the RF amp input provides over 20 dB of attenuation to prevent crossmodulation problems from the high-powered VHF TV signals and other transmissions below 450 MHz. For the mixer, we chose to use a ring-diode balanced mixer circuit, employing wideband input and output matching transformers. This type of mixer provides low noise operation with good crossmodulation performance. In addition, the wideband input and output transformers do away with the necessity of having tuned circuits which require alignment. The ability to choose any convenient output channel is another advantage.

The local oscillator employs a FET in the familiar Hartley circuit. A parallel-tuned circuit is connected between the gate of the FET and common (ground). The drain is bypassed at the operating frequency and the source is tapped up to the tuned circuit's inductance to provide positive feedback. The tuned circuit inductance (L3) is realised by a length of track on the pc board and a small, low-value trimmer provides the tuning capacitance (CV1). Injection to the LO port of the mixer is provided by inductive coupling from L3 and a short length of 50 ohm stripline.

The pc board is double-sided to provide a groundplane area for the UHF circuitry. Output to the VHF TV receiver input can be either 75 ohm unbalanced (via coax) or 300 ohm (via ribbon). A regulated power supply is provided on board and the converter may be powered from a 12 Vac, 500 mA plugpack or a conventional trans-




## HOW IT WORKS — ETI 735

The converter's format is quite conventional — an RF amplifier drives a mixer, local oscillator injection being provided by a variable frequency oscillator, the frequency of which is set by a small variable capacitor. A full-wave bridge rectifier followed by a three-terminal regulator provides regulated 12 Vdc to power the circuitry.

Signals from the antenna are fed to the input of the RF amplifier stage via a two-stage high-pass filter consisting of L1, L2 and C1, C2, C3. This filter attenuates strong signals in the VHF band (below 300 MHz) from overloading the converter and possibly causing crossmodulation problems. The UHF signals are amplified by IC1, a hybrid wideband amplifier chip which provides a gain of about 18 dB over a bandwidth extending from 40 MHz to 860 MHz. The input filter provides around 10 dB attenuation at 300 MHz, around 20 dB at 200 MHz, and more below that. The gain of the amplifier stage is around 15-16 dB across UHF Band IV and around 17-18 dB across UHF Band V. The gain falls off rapidly above 900 MHz. Noise figure is in the region of 6-7 dB, which is quite a bit better than many commercial UHF TV tuners!

The input and output impedances of the OM350 RF amp IC are quoted as 75 ohms, which is convenient.

The output of the RF amplifier is coupled into the mixer via the primary winding of T1.

The mixer employs four Shottky hot-carrier diodes (D1 to D4) in a double-balanced ring mixer circuit. The input and output transformers, T1 and T2 respectively, are wideband types, providing input and output impedance matching. No alignment is necessary — which is one of the reasons we used this type of mixer. The local oscillator injection is applied at point 'x' (the LO port). This type of mixer provides good conversion efficiency, few spurious outputs and has good strong signal performance so that problems with overload and crossmodulation are minimised.

The local oscillator employs a junction FET, Q1, in a Hartley oscillator circuit. This circuit is simple and reliable. The tuned circuit consists of CV1 and L3. The latter is a length of track on the pc board, a 'printed inductor'. Q1 is operated in the common drain mode, positive feedback being obtained by tapping the source across L3. The oscillator can be tuned over a range from about 250 MHz to a little above 600 MHz. Injection to the LO port of the mixer is obtained by inductive coupling. A short length of track adjacent to the 'earthy' end of L3 couples a small amount of energy from the oscillator. This is coupled to point 'x' via a short length of stripline running across the pc board.

The mixing process combines the signals amplified by IC1 and the signal provided by the local oscillator to produce a whole range of 'products' at the output. The principal products are the sum and difference of the input and local oscillator frequencies.

Say the input frequency we want to receive is 526 MHz (lower edge of channel 28). This will be amplified by IC1, along with all the other frequencies passed by the input filter, and applied to the input of the mixer. If we set the local oscillator to 470 MHz, the mixer output will be:

526 − 470 MHz = 56 MHz

This is VHF TV channel 1. If we tune the TV receiver to channel 1, we will be able to receive UHF channel 28. However, the sum of the input and local oscillator frequencies will also result from the mixing process:

526 + 470 MHz = 996 MHz

But the TV receiver will not respond to such a high frequency. A signal from UHF channel 50 (694-701 MHz) may appear at the output too:

694 − 470 MHz = 224 MHz

But that's outside the range of the VHF TV receiver. If we set the TV receiver to channel 6 (174-181 MHz), we will be able to receive channel 50 by setting the converter's local oscillator to 520 MHz.

Reception of a UHF station can also be obtained with this converter design by tuning the local oscillator above the channel frequency. For example, to receive channel 28, which occupies 526-533 MHz, assuming we have the TV receiver set on channel 1, the converter local oscillator should be set to 589 MHz:

589 − 533 MHz = 56 MHz.

But, if there is a signal 56 MHz above the local oscillator frequency (otherwise known as the 'image' frequency), i.e: 589 + 56 MHz = 645 MHz (UHF channel 43), it will be received equally well — and you'll have terrible interference if there's a station on that channel! With this converter, and the current arrangement of channel allocations, it is best to tune in a station with the oscillator set on the low frequency side of the desired channel. In addition, it is best to use channel 1 (or an adjacent unused channel) to receive UHF stations in Band IV (520-580 MHz) and an unused channel between 5A and 11 to receive UHF stations in Band V.

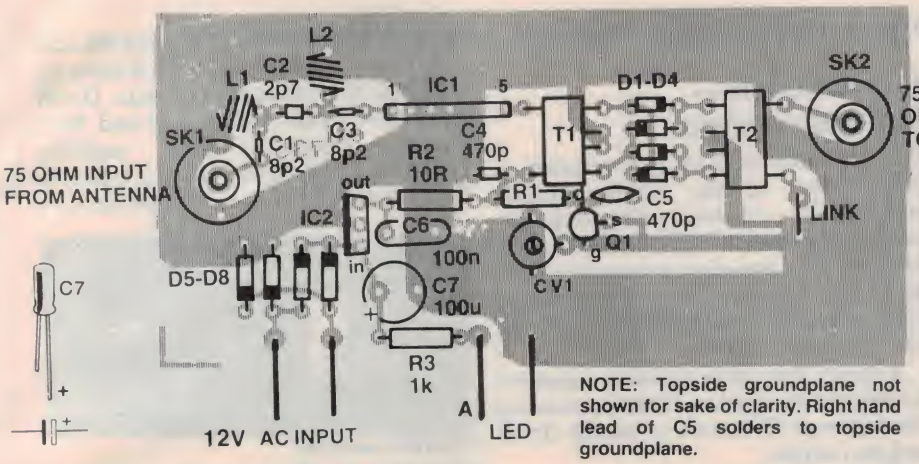
Power is provided by a full-wave bridge rectifier involving diodes D5 to D8, input being derived from a 12 Vac (nominal) source. An indicator LED (LED1) is driven from the output of the rectifier. Capacitor C7 is the rectifier smoothing capacitor. A three-terminal regulator, IC2, employing either a 78L12 or 7812, provides a regulated 12 Vdc supply for the RF amp, IC1, and the oscillator FET, Q1. The regulated supply ensures good oscillator stability. Capacitor C6 bypasses the output of the regulator, IC2, and prevents it bursting into HF oscillation. Resistor R2 prevents interaction between IC1 and IC2 at low frequencies, and C4 provides an RF bypass for the supply rail to IC1, which goes to the output pin (pin 5) via the primary of T1.

RF bypassing for the drain of Q1 is achieved by C5, and the power supply rail is decoupled via R1.

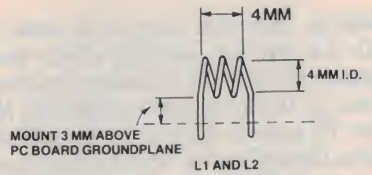
The output impedance of the mixer can be matched to an unbalanced 75 ohm load or to a balanced 300 ohm load by having a different secondary wound on T2. The impedance transformation ratio provided between the primary of T1 and the secondary of T2 will depend on the square of the ratio of their turns. With two turns on the primary of T1 and two turns on the secondary of T2, the impedance transformation will be 1:1. In this instance, one side of the secondary of T2 is grounded to provide an unbalanced output to match coax cable. If the secondary of T2 is wound with four turns, the output impedance will be given by:

$75(4/2)^2 = 75 \times 4$
$= 300$ ohms

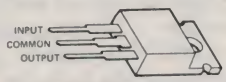
Thus, four turns on the secondary of T2 will provide a balanced match to 300 ohms.



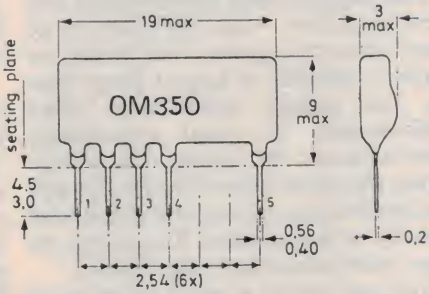

NOTE: Topside groundplane not shown for sake of clarity. Right hand lead of C5 solders to topside groundplane.

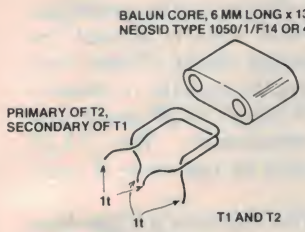


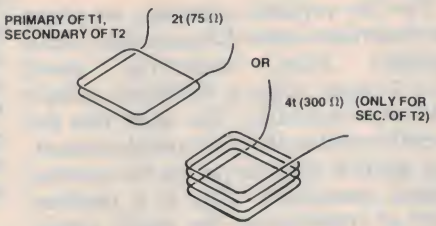

L1 AND L2 ARE WOUND WITH 22 SWG TINNED COPPER WIRE. THREE TURNS EACH, ON A 4 MM DIAMETER FORMER, AND SET TO A LENGTH OF 4 MM EACH. MOUNT THEM SUCH THAT THE LOWER PART OF EACH COIL IS ABOUT 3 MM ABOVE THE BOARD GROUNDPLANE.




7800 SERIES POSITIVE VOLTAGE REGULATORS




former. Overall gain is around 12 dB and the noise figure is around 6-7 dB. This sort of performance is more than adequate for normal service reception of UHF transmissions.

No doubt some readers are curious as to why we didn't design a tuner employing voltage tuned varicaps to tune the local oscillator and/or RF tuned circuits. Firstly, suitable varicaps having the required characteristics for these frequencies were not readily available. We did experiment with a few types that were available, as well as with some common high frequency silicon diodes, but results were very poor owing to the low Q and high losses of the components. Hence, we opted for the circuit design described here.

## Construction — single channel version

We shall describe the construction of the single channel version first. The tuneable version is actually just a modification of the single channel version.

The converter is constructed on a double-sided pc board having a fibreglass substrate. A phenolic substrate board will not work in this application. The top side is predominantly copper, which serves as a groundplane, small areas being etched away where components pass through from the top to the bottom side tracks. The complete converter fits on to the one pc board, including the rectifier and power supply regulator components.

Construction is best commenced by mounting all the minor components. Leave the input and output sockets, coils and mixer transformers until later. All components should be mounted with the *absolute minimum lead length*. Press them hard down on the board. However, the input high pass filter coils, L1 and L2, are mounted about 3 mm above the board, to avoid the groundplane dampening their Q.

A number of components are soldered on both the top and the bottom sides of the board. These are: the anodes of D6 and D8 (in the rectifier), one lead of C4, plus the earth stake, the centre-tap connection of T1, the earth end of the output link (for 75 ohm output) and the earth ends of L1 and L2.

The OM350 RF amplifier IC must be seated hard down on the board, as should Q1 and the mixer diodes D1 to D4. Watch the orientation of the semiconductors and the rectifier filter capacitor, C7. Note that the OM350 can only be inserted one way, but the local oscillator FET, Q1, has its source lead — the centre one — offset from the others. This lead must be bent over so that the FET can be inserted the right way round. This is necessary to give the correct length of track on the board for the source feedback tap on L3 — which is a printed circuit inductor.

Take care when soldering CV1 in place as conducted heat can distort the body of the component, ruining it.

Having mounted the minor com- ▶

### PARTS LIST — ETI 735

**Resistors** — all ½W, 5%
- R1 ..... 150R
- R2 ..... 10R
- R3 ..... 1k

**Capacitors**
- C1, C3 ..... 8p2 ceramic NPO
- C2 ..... 2p7 ceramic NPO
- C4, C5 ..... 470p ceramic
- C6 ..... 100n greencap
- C7 ..... 100u/16 V electrolytic
- CV1 ..... 2-18p miniature film trimmer (see text) OR 2-15p miniature air trimmer with 4.8 mm (3/16") shaft.

**Semiconductors**
- D1-D4 ..... 5082-2800 (four-off) or matched set of 5082-2804 Hewlett Packard hot carrier diodes
- D5-D8 ..... 1N4001, 1N4002 etc or similar
- Q1 ..... 2N5245 FET (no substitutes)
- IC1 ..... OM350 Philips wideband amp IC
- IC2 ..... 78L12 or 7812, 12 V three-terminal regulator.
- LED1 ..... TIL220R or any suitable LED.

**Miscellaneous**
- SK1, SK2 ..... Belling & Lee pc-mount coax sockets
- L1, L2 ..... see text and diagrams
- T1, T2 ..... see text and diagrams
- T3 ..... 12 Vac, 500 mA plugpack

ETI-735 pc board (double-sided, fibreglass necessary); pc board stakes; tinned copper wire; hookup wire; vernier drive (for tuneable version); 6.5 mm to 4.8 mm shaft reducer (for tuneable version); box to suit.

ponents, the next step is to wind the coils L1 and L2, and the mixer transformers T1 and T2. Winding details are given in the diagrams on page 38. Note that T2 can be wound in two different ways, depending on whether you choose to have a 75 ohm unbalanced output (coax) or 300 ohm balanced output (ribbon). If you choose a 300 ohm balanced output, the small link near the output socket is left out and the ends of the secondary of T2 connect direct to a length of 300 ohm ribbon, soldered on the underside of the pc board.

The converter may be mounted in any convenient box — but don't put the pc board close to a panel. Use 12 mm (or longer) standoffs to keep it away from the box panels, which may affect performance. To avoid unnecessary terminations, the input and output cables should be taken directly through the lid of the box you use and terminated directly on the pc board. This is why we have used pc-mounted coax sockets.

You can mount a small transformer in the box to power the converter, or you can use a plugpack. The transformer or plugpack should have an output of 12 Vac, rated at about 500 mA. Transformers and plugpacks with this rating are cheap and quite common. While the converter doesn't draw anything like 200 mA, the rectifier output must be several volts above the three-terminal regulator's output voltage. As less than full load is drawn from the transformer or plugpack, its output will be high enough to meet this requirement.

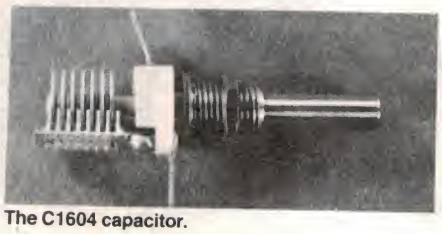
If you choose to use a plugpack, mount a suitable insulated two-pin socket on the box housing the converter. Dick Smith stores stock a suitable ac plugpack, catalogue number M-9555, while Ferguson market a plugpack designed to power doorbells, model PPB 12/500.

## Construction — tuneable version

The tuneable version just requires a modification to the single channel version. To construct the tuneable version, commence by constructing the converter as per the instructions just described, but leave out the trimmer capacitor CV1 (not needed) and Q1 (which must be inserted later).

A small, low value variable capacitor is added to the local oscillator, replacing the trimmer CV1, and a vernier drive and dial added.

For the variable capacitor, we chose an American-made Johnson type with a ceramic base, measuring about 12 x 14 mm, with a threaded spindle and nut mounting. The shaft has the variable plates attached and the mounting spindle also serves as the moving plates connection. This is a common form of construction for small, single-gang variable capacitors for those readers who are not familiar with the beasts. The type we chose to use in the prototype has the moving plates and the fixed plates each milled out of a brass block, which provides excellent mechanical and electrical stability. These capacitors are available in different values and we would recommend you use one with a maximum capacitance of 15 pF. The exact one we wanted was not available when we constructed the prototype so we used one with a maximum capacitance of 20 pF and cut down the fixed plates to obtain the required value. This is visible in the close-up photographs. We purchased ours from General Electronic Services Pty Ltd of 99 Alexande St, Crows Nest NSW 2065, but kit and component suppliers may stock them by the time this issue goes on sale. David Reid Electronics (in Sydney and Melbourne) stock a small variable capacitor, type C1604, that is suitable for this project. It is somewhat smaller than the one shown in the prototype, measuring 9 mm square around the base and standing about 17 mm high above the base of the spindle. It comes in three values of 20 pF, 14 pF and 8.5 pF maximum capacitance. The 14 pF model is the one to use here; it costs around $7.

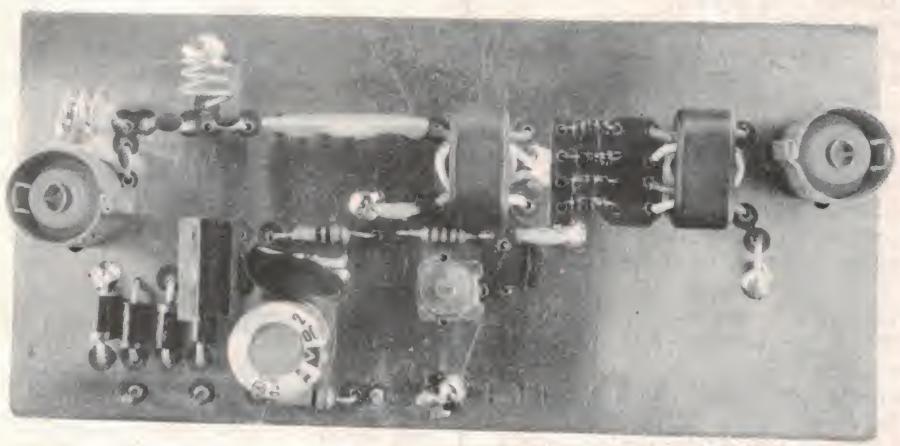


The C1604 capacitor.

Each capacitor requires a 6 mm hole to be drilled in the pc board for the spindle. This is drilled through the pc board adjacent to the end of the local oscillator inductor strip (L3), the hole centre being spaced about 9 or 10 mm from the pad at the very end of L3. The capacitor from David Reid Electronics (C1604) could be placed a little closer if you wish. Whichever capacitor you use, it must clear adjacent components. The main requirement is to place the solder tag for the fixed plates connection above the pc board hole for the gate of the local oscillator FET, Q1.

When securing the variable capacitor to the pc board, make sure the nut gets a good grip so that the shaft and spindle are well connected to the groundplanes on the top and bottom of the board. Ensure that the areas of copper on the board surrounding the spindle hole are clean and bright before installing the capacitor.

With the capacitor installed, Q1 needs attention. The drain lead goes in the original hole (see the overlay), but the source lead now goes in the hole where the gate lead went on the single channel version (again, refer to the overlay). Now, pass a short length of tinned copper wire through the hole in the pad on the very end of the local oscillator inductor strip (L3), up to the lug connecting to the fixed plates on the variable capacitor. Solder the wire to the board, then bend the lug on the capacitor down towards the board and solder the free end of the wire to the lug. Take the gate lead of Q1, bend it towards the capacitor lug and solder it in

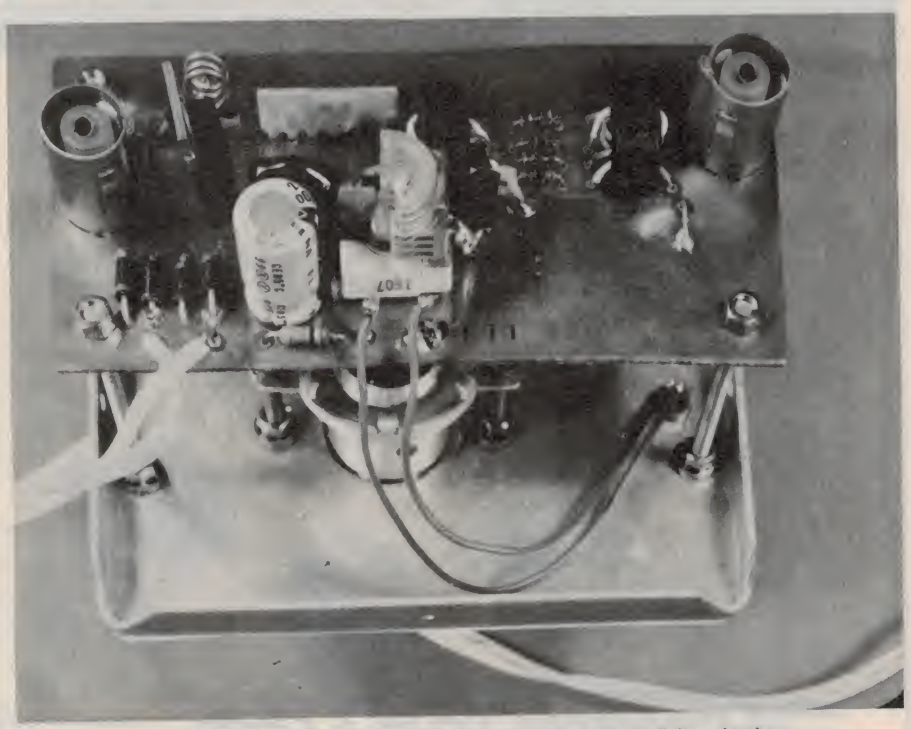


The completed single-channel converter. Topside of the board is largely copper with 'let-outs' where components pass through. Input is on the left, output at right.

place. The one thing to remember here is to *keep all leads as short as possible.* The accompanying close-up photograph shows how we did it.

The converter may now be mounted in a box, so that the vernier drive and dial can be installed. The vernier drive we used is a Jackson dual-ratio type having a 2:1 and a 6:1 action. This is designed to couple to a 6 mm (¼") diameter shaft. The Johnson capacitor specified has a 4.8 mm (3/16") diameter shaft, while the C1604 capacitor from David Reid Electronics has a 4 mm diameter shaft. You will need an appropriate split-tube shaft reducer to slip over the capacitor's shaft, depending on which particular type you are using.

We mounted our tuner in a small Horwood box, type 34/6/D. This consists of an aluminium extrusion 100 mm wide by 75 mm high and 75 mm deep with a panel in each end secured by self-tapping screws. The converter and dial mechanism are secured to one end panel and the RF input/output and power supply cables are passed through holes in the other. Drilling details to mount the converter and dial mechanism are given in the drawings below. The pc board is secured to the front panel by four 38 mm long (1½") 6 B.A. bolts, while the vernier dial drive mechanism is mounted using two 25 mm long (1") 6 B.A. bolts. All six bolts have countersunk heads to permit the front panel transfer (such as Scotchcal) to sit flat on the panel. General construction is visible from the photographs here. The best way to go about the mechanical assembly is as follows: first, carefully mark out and drill the front panel as per our detail drawing. Secure all six bolts to the panel using washers under each nut. Thread another nut on each bolt. Slip the vernier drive over its two mounting bolts and position the two nuts such that the mounting lugs of the drive are about 15 mm from the panel. Secure the drive mechanism with two more nuts and washers, making sure the drive shaft passes through the panel at a right angle otherwise your dial pointer will not move parallel to the front panel.

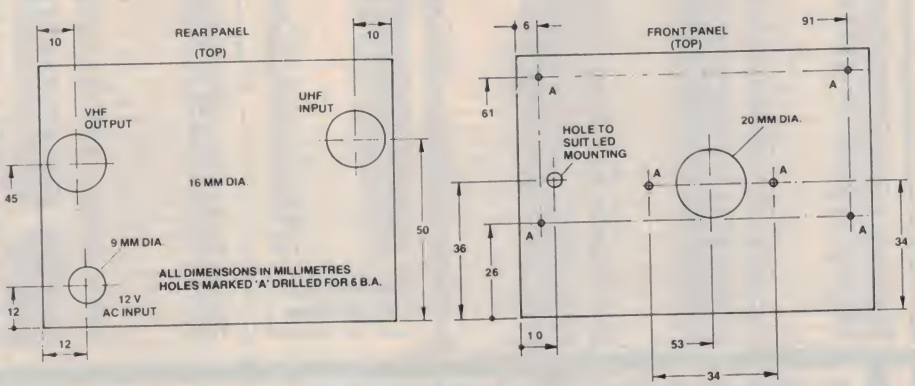


The completed tuneable version showing how we mounted the board and dial mechanism.

Now, slip the shaft reducer over the shaft of the variable capacitor. Assemble the pc board onto the mounting bolts and position the nuts on each bolt so that the board is about 32 or 33 mm from the panel. The capacitor shaft should line up with the drive coupling. Don't secure the board yet. Tighten the grub screws on the drive coupling to secure the capacitor shaft. Now you can secure the board with four more nuts.

Before you assemble the dial pointer mechanism to the vernier drive, fix the indicator LED in place and then attach the panel artwork. We used a Scotchcal panel, but only general markings are shown, as the exact channel positions (or frequency markings) will depend on which VHF channel you select as the converter's output. With the panel artwork in place you can assemble the dial pointer mechanism to the vernier drive. ▶

Close-up of the FET and tuning capacitor in the tuneable converter, showing where the capacitor is mounted and how the FET's gate lead is bent over to the capacitor's lug. The source lead now goes in the original gate hole.




Panel drilling details for the Horwood box in which we housed the tuneable converter.

We cut a piece of 3 mm thick perspex to shape and put a line on it with black ink.

The rear panel of the box has three holes drilled in it, two to pass the input and output cables and one, which is grommeted, to pass the power supply input lead. Pass the ac supply lead (length of figure-8 flex) through the grommeted hole and the input and output cables through the appropriate holes and then assemble the rear panel to the case. Wire up the ac supply to the pc board and you're ready to roll!

## Setting up

Setting up the single-channel version is quite simple. We presume you already have an antenna (see the March issue). Install a short jumper cable from the converter's output to the TV receiver's input. Attach the ac power source to the converter (plugpack or what-have-you), plug in your UHF antenna and switch on.

You will need to select an appropriate unused channel on your TV receiver. For UHF stations in Band IV (channels 28 to 34), VHF channel 1, or an adjacent unused channel, can be used. For Band V UHF stations (channels 38 to 63), select one of the higher VHF channels, such as channel 6 or 8.

First ensure your antenna is pointing in the right direction. Then, using an insulated alignment tool, adjust CV1 for best reception on the UHF channel you want to receive. Start with CV1 set at maximum capacitance so that the local oscillator frequency is tuned *upwards*. It is possible to tune Band IV stations by setting the local oscillator above the channel of interest, but this is not recommended as it may be possible to experience interference from stations on the 'image' frequency. For example, say you have chosen VHF channel 1 (56 MHz) as the converter output frequency. You can receive UHF channel 28 by setting the local oscillator to 470 MHz (526 - 56 MHz). You can also receive channel 28 by setting the local oscillator to 589 MHz. However, a station on 645 MHz (channel 43) may be received equally well. This channel is not occupied at the moment, though.

Setting up the tuneable version is very similar. First, set the dial to the lowest frequency (capacitor plates fully meshed). Attach the antenna and jumper cables and the ac power input from the plugpack, and power up. For the tuneable version, one of the higher frequency VHF channels should be selected on your TV receiver. If you want to go right up to UHF channel 63, you'll have to use VHF channel 11, as the converter's local oscillator in the tuneable version does not go above 600 MHz as it does in the single channel version.

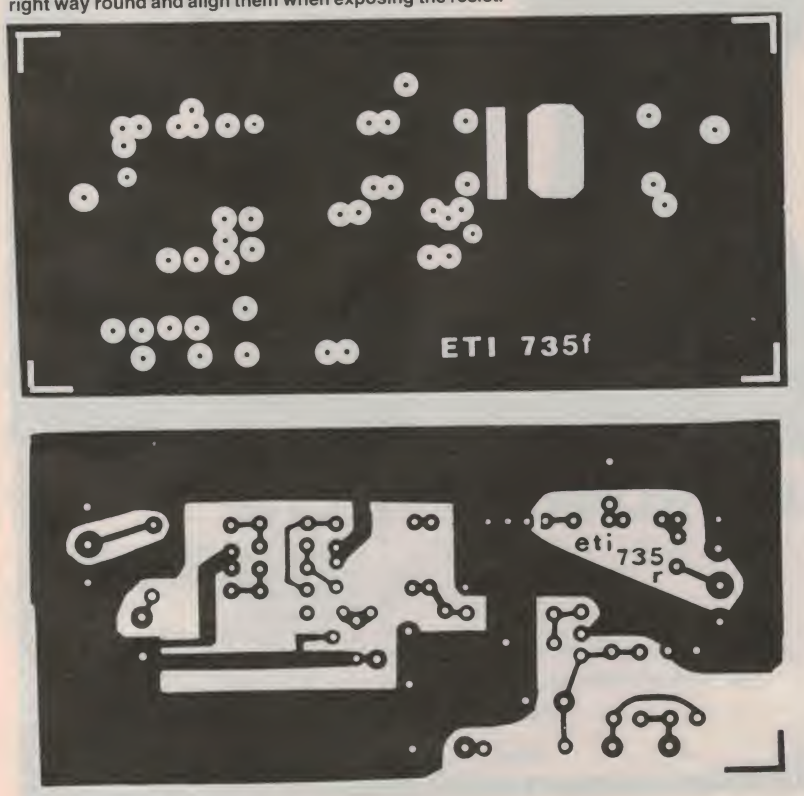
With everything set up, rotate the dial until you obtain good reception of the station of interest. Dial positions of channels can be noted on the panel with a Chinagraph pencil and the channel number put on later with rub-down lettering such as Letraset.

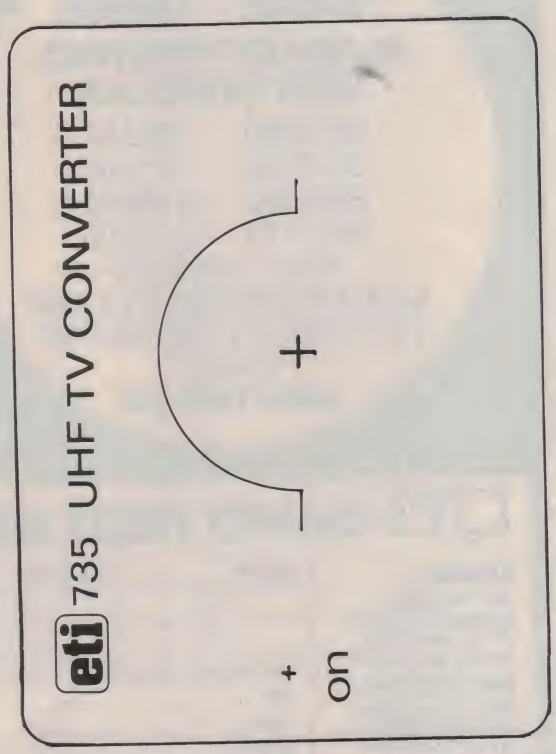
If you find you need to improve reception, experiment with the position and direction of the antenna. If necessary, further improvement can be obtained by using a masthead amplifier, such as our ETI-729, published in the April issue.

## Amateur TV use

The converter is eminently suited to amateur TV applications in the 420-450 MHz (70 cm) amateur band. Two 'channels' are used: 425-432 MHz (vision carrier on 426.25 MHz) and 443-450 MHz (vision carrier on 444.25 MHz). The local oscillator range in this converter is more than adequate to cover these two frequency bands, set to either the 'high side' or the 'low side'. However, the input high-pass filter will require some modification. This is simple — squeeze both coils until they're just under 3 mm long! This will bring up the gain around 400 MHz and still provide a reasonable roll-off below 250 MHz to attenuate the strong VHF TV station signals that may bring crossmodulation problems. ●

Full-size artwork for the front and rear sides of the pc board. Take care to place them the right way round and align them when exposing the resist.




Full-size artwork of the front panel for the tuneable converter.

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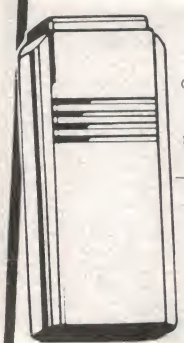
Answers & records 24 hours a day.


DON'T pay over $400!

Capture important calls WITHOUT returning to your office!



*With this optional remote beeper you can actually dial your number from any other phone & listen to any messages that have been recorded – imagine how handy that would be for busy people on the move. You can capture important calls without having to go to the office.

*Remote beeper available $39.00

**Direct import & latest microprocessor technology have halved the cost of telephone answering machines from**

# DICK SMITH

# Huge price breakthrough

Traditional telephone answering units are enormously complex and expensive. In this revolutionary unit most of the components have been replaced by one "microprocessor" (computer) integrated circuit which not only means greater reliability but also vast savings in cost. **To purchase this unit outright you will probably spend less than one years lease payments on competitive units**

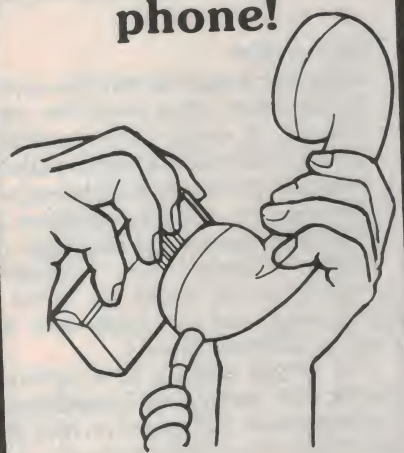
## NOT AS GOOD·

This unit has some tremendous advantages over competitive units however we must first tell you of one disadvantage. With competitive units selling for $400-$500 a sales representative will call, demonstrate and quote you. However, because of the extremely low price of this unit we can only sell it directly "over the counter" or by mail order. The profit we make wouldn't even run a traditional salesman's car for very far!

# but far better

Many telephone answering units (including this one) can have remote beepers. This means that when you wish to retrieve a message, you simply 'phone your number, hold the beeper to the 'phone and the telephone answering machine then rewinds to the start of your first message and plays back. However, with most units if you then wanted to erase these messages and rewind, it was either impossible or extremely complicated. This unit solves the problem as you can command the machine to rewind from your beeper at any time.

# Remote control of your machine from any other phone!



# easy to install

The telephone answering unit simply plugs into the power and connects to your telephone (Telecom install a socket at a nominal charge). We even supply instructions on how you can easily install it yourself in seconds where Telecom regulations do not apply.

# incredibly small

Microprocessor technology has reduced the machine to 25.5 x 15 x 6cm. (your telephone sits on top perfectly) and the unit will record up to 45 messages on the standard cassette tape (many other machines have special tapes costing over $20.00).

You don't have to pay for special tapes costing $20 or more!

# Features:

- All solid state – non mechanical switches.
- Electronic cassette mechanism (patent pend).
- All functions computer controlled.
- Acknowledges all commands.
- Messages received signal.
- "Fail safe" signal – signals if you forget to insert cassette.
- Uses standard cassette.
- Supplied with pre-recorded cassette tape – unit ready for immediate use.
- Supplied with microphone for personal recording of outgoing message.
- Computerised "Auto Record" – just speak into the microphone and the computer does it all.
- Monitor allows undetected screening of callers.
- Skip mode – automatically jumps to start of next message.
- No listening to outgoing message. Only hear the message received.
- Remote beeper allows you to listen to your messages from any telephone.
- Choice of keeping messages or resetting to fresh start, from any telephone.
- Unit has "No message received" signal on remote call-in.
- Last message received signal.
- Signal for tape fully recorded with incoming messages.
- Book size – fits under your telephone.

# no wasted time

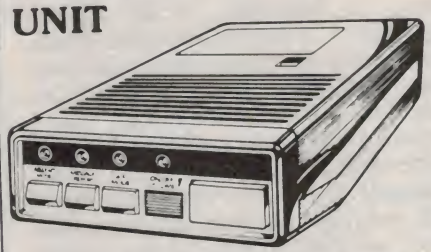
With our unit there is a special beep tone that tells you the moment you call in if there's a message. It also tells you if you have finished listening to the last message.

This saves you time and money!

# try it yourself– no obligation

We are so confident of this computer controlled marvel that we are happy for you to try it yourself for 14 days and if you are not completely satisfied, simply return it to us in its original condition and we will refund your money in full.

## XK-2100 TELEPHONE ANSWERING UNIT



Cat. Y-2173
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**$199.00**

## OPTIONAL REMOTE BEEPER

**(Allows you to interrogate machine from another phone).**

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# DICK SMITH ELECTRONICS

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# Electronic humidity meter can double as a controller

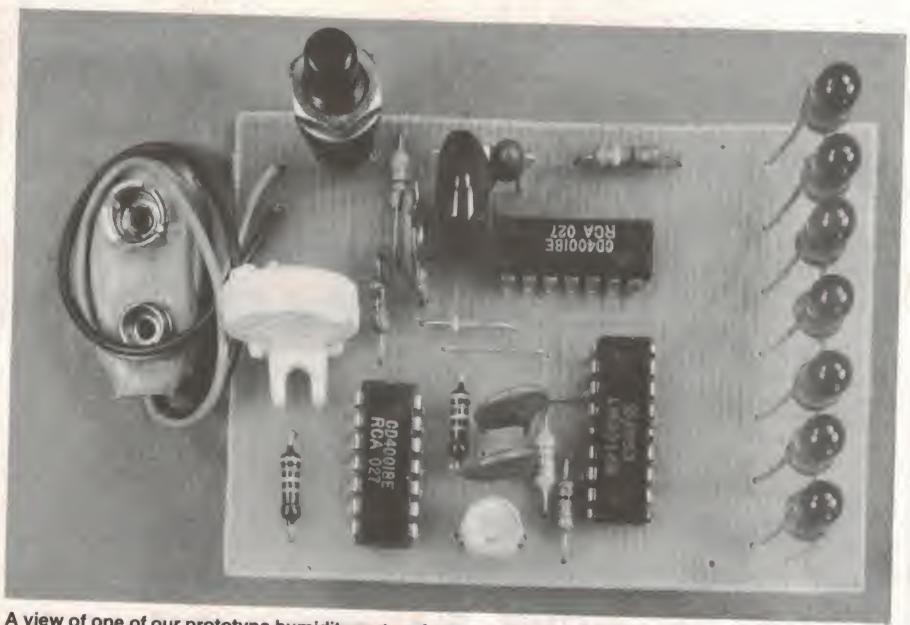
## Graeme Teesdale

This project can be built to give a readout of relative humidity either on a LED dot-mode display or a conventional meter. In addition it can be used with a following project as a controller to turn on and off a water mist spray in a hothouse, for example.

MEASURING environmental parameters such as temperature, wind speed and direction, etc, are relatively simple problems in electronics. But when it comes to humidity — or relative humidity — a stumbling block arises. The Bureau of Meteorology, and most other agencies or people interested in measuring relative humidity ($H_{rel.}$), employ wet bulb/dry bulb thermometer instruments and a conversion table. Attempts to emulate the wet bulb/dry bulb technique electronically have been tried, using thermistors, in the past but the technique has not met with a great deal of acceptance. It's "fiddly" and offers few advantages — other than a direct readout of relative humidity — over the wet bulb/dry bulb method.

Now, doubtless many an electronics engineer and hobbyist has turned their mind to the problem of a suitable electronic sensor over the years — finally turning to more stimulating things after running up a number of frustrating blind alleys. Not so the Philips organisation. Somewhere along the line they ran up an alley that bore fruit (. . . pomegranates and paw-paws, but that's another story entirely!). In 1979, Philips released a 'capacitive humidity sensor for consumer applications', type number 2322 691 90001. The device characteristics and applications circuitry were described in Philips Technical Note 134, issued 12 September 1979.

The capacitive humidity sensor.




A view of one of our prototype humidity meters featuring the LED display. Note the sensor mounted on the board at the left, adjacent to the battery clip.

This project has been designed to use that sensor and employs a measurement technique described in that Technical Note. To cater for as wide a range of readers' interests and applications as possible, we have designed this project to display the relative humidity reading either on a conventional moving-coil meter or on a dot-mode LED display, using the ubiquitous LM3914 to drive seven LEDs indicating relative humidity over the range 35% to 100%. For those who wish to employ the project in an automatic humidity control system, it can be coupled to our Universal Relay Driver project, ETI-257, also described in this issue.

This project is not intended as a true scientific instrument as accuracy of the sensor is only a few per cent, but for most general domestic applications it should prove more than adequate.

## The sensor

A humidity sensor to suit the applications described must meet two major objectives: it must have predictable behaviour and good long-term stability. In addition, the sensor must be ruggedly constructed for reliable operation and be simple to operate and maintain.

Philips claim their capacitive humidity sensor meets the above requirements, and our experience with them would bear this out.

The device consists of a perforated plastic case containing a membrane of non-conductive foil coated on both sides with gold, the membrane and coating forming, respectively, the dielectric and electrodes of a parallel plate capacitor.

Changes in relative humidity cause a change in the sensor's capacitance. With suitable circuitry, this change can be converted into a dc voltage that can

be used to give a direct reading of relative humidity, or to serve as the monitoring signal of an automatic humidity control system.

The sensor is designed to measure relative humidity between 10% and 90% and has the advantage that its long-term characteristics are unaffected by condensation of water on the foil surface.

The relationship between relative humidity and capacitance for the sensor is somewhat non-linear. To obtain a direct indication of humidity, either a non-linear scale must be employed on the readout or the circuitry output signal must first be processed by a linearising circuit.

The sensor will not respond immediately to a very rapid, large-scale change in relative humidity. For example, if the relative humidity jumps from 10% to 43%, it will take the sensor round three minutes to again provide a stable reading, according to the Philips data.

If the relative humidity exceeds 90%, even slight temperature variations can lead to condensation of water on the sensor foil; this will cause measurement errors and a considerable increase in response time. The sensitivity of the sensor is not specified below a relative humidity of 10%, although it would be feasible to measure values below this.

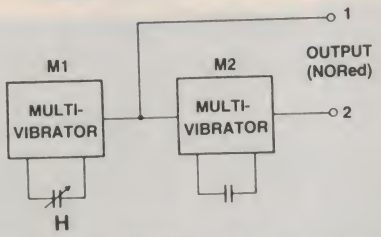



*Figure 1.* **Block diagram of the circuit technique employed in the humidity meter. Two synchronised multivibrators provide an output signal which varies proportional to variations in relative humidity. 'H' is the humidity sensor.**

## The circuit

We've used a circuit technique suggested in Philips' Technical Note 134. The operating principle is based upon measuring the pulse width differences between two synchronised multivibrators (see Figure 1). M1 is controlled by the capacitive humidity sensor, the output pulse width varying as the humidity varies. The second multivibrator, M2, has a fixed pulse width, set by a fixed capacitor. The output of each capacitor is combined in a NOR gate which produces an output signal that varies in width proportional to the difference between the multivibrator output pulse widths (see Figure 2). This is very convenient as the difference signal will be virtually independent of temperature and voltage,

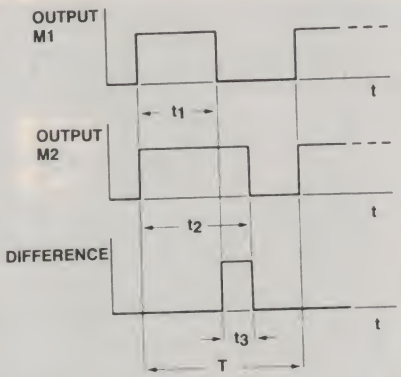
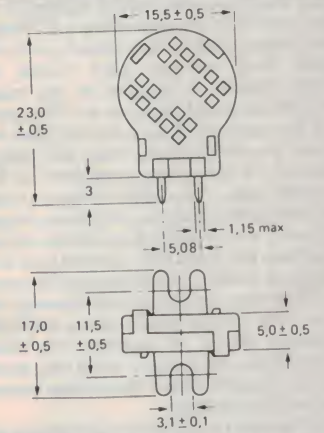


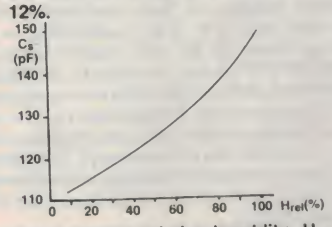

*Figure 2.* **Illustrating how the output signal, $t_3$, is obtained. If $t_2$ is fixed and $t_1$ varies with variations in humidity, $t_3$ will vary in direct relation to it.**

provided the characteristics of both multivibrators are identical and the fixed capacitor controlling M2 has a temperature coefficient as close as possible to the capacitive humidity sensor. The first requirement is easily met as both multivibrators employ two gates from a 4001 quad NOR gate package.

To provide M2 with a temperature characteristic closely matching that of the humidity sensor, several positive temperature coefficient ceramic capacitors in parallel are used. A small value trimmer capacitor permits adjustment of this multivibrator to calibrate the ▶




**The relationship between $H_{rel}$ and $C_s$ (sensor capacitance) can be approximated by:**
$C_s/C_s(12\%) = 0.985 + 0.34(H_{rel}/100)^{1.4}$
**where $C_s(12\%)$ is the capacitance at $H_{rel}$ = 12%.**



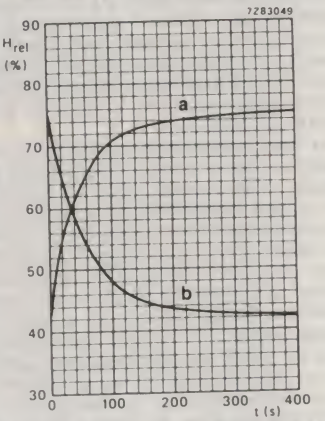

**Relationship between relative humidity, $H_{rel}$, and sensor capacitance, $C_s$.**

## Characteristics of the humidity sensor

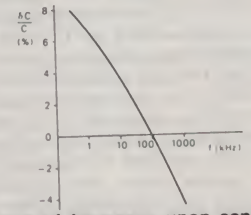
| | |
|---|---|
| Capacitance ($T$ = 25°C, $H_{rel}$ = 43%, f = 100 kHz) | 122pF ± 15% |
| Sensitivity ($H_{rel}$ = 43%) | (0.4 ± 0.05)pF/% |
| Operating frequency range | 1 kHz to 1 MHz |
| Temperature dependence (over operating frequency range) | ≈ 0.1%/K |
| Measuring range | $H_{rel}$ between 10% and 90% |
| Operating temperature range | 0°C to 60°C |
| Maximum operating voltage (ac or dc) | 15 V |
| Dielectric loss (tan δ) (at T = 25°C, f = 100 kHz) | ‹ 35 x 10−3 |
| Response (90% value) | |
| within the range of $H_{rel}$ = 10% to 43% | ‹ 3 min. |
| within the range of $H_{rel}$ = 43% to 90% ($T_{amb}$ = 25°C, in circulating air) | ‹ 5 min. |
| Hysteresis at one cycle ($H_{rel}$ ⧫ 10% ⧫ 90% ⧫ 10%) | ≈ 3% ($H_{rel}$) |

**Capacitance of the humidity sensor at four different frequencies (nominal values)**

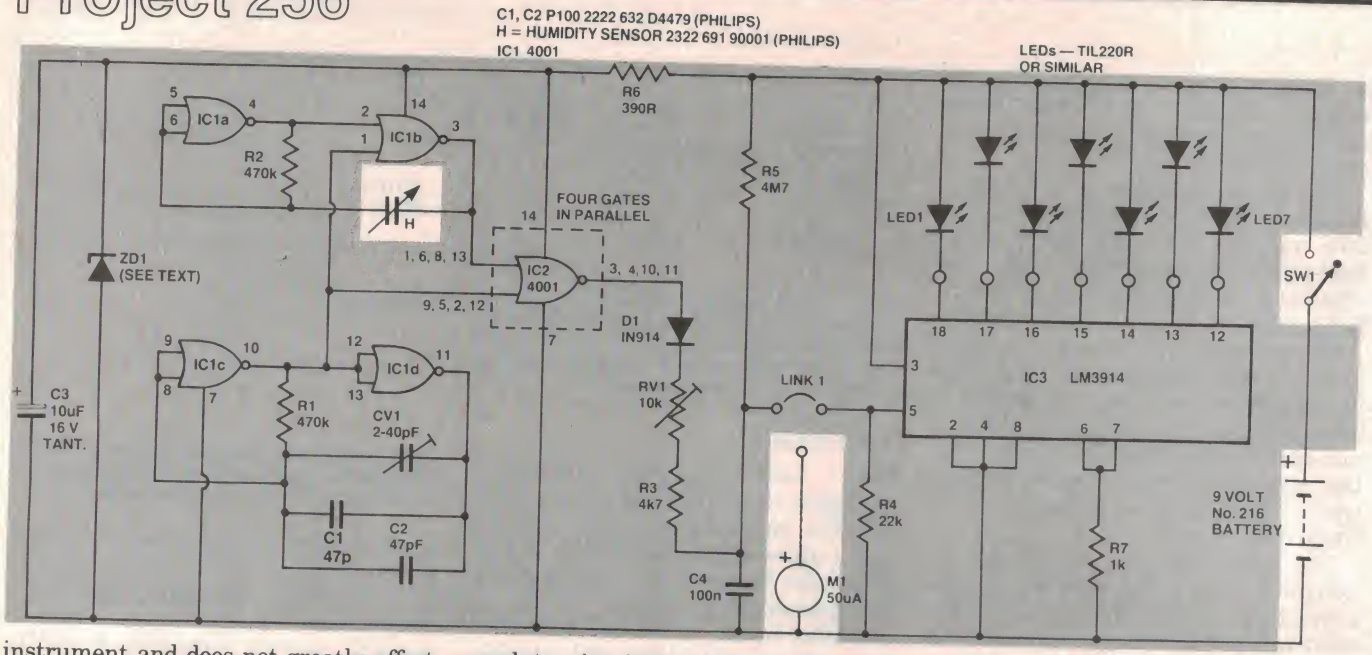
| frequency f (kHz) | $C_0$ (pF) ($H_{rel}$ = 0%) | △C (12%) (pF) | △C (100%) (pF) |
|---|---|---|---|
| 1 | 116.1 | 3.6 | 45.5 |
| 10 | 112.7 | 3.5 | 44.2 |
| 100 | 109.0 | 3.3 | 42.7 |
| 1000 | 104.6 | 3.3 | 41.0 |




**Response of sensor to rapid changes in humidity: (a) from 43% to 75%, (b) from 75% to 43%.**




**Influence of frequency upon sensor capacitance, $C_s$, based upon a reference frequency of 100 kHz. (Note this curve also represents the influence of frequency on △C and $C_0$.)**




instrument and does not greatly affect the temperature coefficient.

The output voltage from the NOR gate used to combine the two pulses is obviously directly related to the supply voltage, so we have used a simple zener regulator circuit to avoid supply voltage variations affecting the accuracy of the instrument.

Readout can be on a conventional meter or via a LED dot-mode display. A linearising circuit has been employed, as suggested by Philips, to prevent 'cramping' of the readout scale — regardless of whether a meter or the LED circuit is used. Its operation is explained in 'How It Works'. The LED display provides relatively coarse steps but can be

## HOW IT WORKS — ETI 256

Two synchronised multivibrators are employed and their outputs compared to provide a signal proportional to relative humidity. This output signal is first 'linearised' and then used to drive either a moving-coil meter or a LED dot-mode display employing an LM3914 dot/bar-mode display driver IC. One multivibrator has a period fixed by a set of ceramic capacitors and a trimmer capacitor (for calibration) while the other has a period set by the capacitance of the Philips capacitive humidity sensor. Thus the difference in period between the two multivibrators is a measure of the relative humidity, $H_{rel.}$.

The two multivibrators are made up from two pairs of gates from a 4001 quad NOR gate package. This ensures both multivibrators have similar characteristics. IC1a and IC1b form one multivibrator, the period of which is controlled by 'H', the capacitive humidity sensor. IC1c and IC1d form the other multivibrator, the period of which is set by the parallel combination of CV1, C1 and C2. CV1 permits adjustment of this multivibrator's period for calibration purposes (zero setting). The two multivibrators are 'synchronised' — turn on at the same time — by having pins 1, 12 and 13 tied together. To illustrate how each multivibrator works, we shall examine that using IC1c and IC1d.

When power is applied, the capacitance made up of CV1, C1, C2 will initially appear as a short circuit, thus coupling pin 11 to the input of IC1c (connected as an inverter), pins 8, 9. If we assume pin 11 is low initially, this will hold the input of IC1c low, forcing the output (pin 10) high. As IC1d is connected as an inverter, its input will be high, holding the output low. The CV1/C1/C2 capacitor will charge via R1. When the voltage across this capacitance rises above the logic low threshold, the input of IC1c will be high and its output will go low. This brings the input of IC1d low, and its output (pin 11) will go high. This will now charge the CV1/C1/C2 capacitor in the reverse direction, via R1. When the voltage across R1 drops to the logic low level, the input of IC1c will again be low and its output (pin 10) will go high. This drives the input of IC1d high, driving its output low, and the whole cycle repeats.

The multivibrator involving IC1a and IC1b is synchronised to the other by having one input (pin 2) of IC1b tied to the output of IC1a. Only when both inputs of IC1b are high can the output of IC1b (pin 3) go low. Thus the outputs of both multivibrators (pins 3 and 11) go low together.

The humidity sensor has a positive temperature coefficient of about 100 parts per million. Accordingly, so that the other multivibrator has a similar characteristic, positive temperature coefficient capacitors with a rating of 100 ppm are used. The characteristic of CV1 has little effect.

The outputs of both multivibrators are combined in a NOR gate to provide positive-going pulses, the width of which will vary depending on the difference in pulse widths between the two multivibrators. As H varies with relative humidity, the pulse width at the output of IC2 will vary in direct relationship. The four gates in IC2 are connected in parallel to provide a low impedance output to drive the 'linearising' circuit. This part of the circuit is shown in Figure 4 here, and for the sake of explanation the meter circuit output is included.

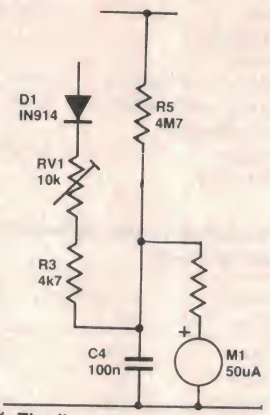



*Figure 4.* The linearising circuit. The meter is included for the sake of explanation. R4 replaces Link 1.

Pulses from the output of IC2 charge C4 via D1, RV1 and R3. At the same time, a discharge current proportional to the voltage across the capacitor flows via the meter circuit. An additional current is supplied to the meter circuit from the supply line, via R5. The amplitude of the output pulses from IC2 does not vary, but the width does. Thus the charge supplied to C4 will vary in proportion to the pulse width ratio. The output voltage across C4 supplied to the metering or display circuit will thus vary non-linearly. By judicious choice of the values of C4, RV1/R3 and the load (R4, including the meter), the relationship between relative humidity and the current through R4 (and thus the voltage across it) can be made substantially linear. In practice, the scale becomes a little cramped at the top end, but is considerably better than if the voltage across C4 were read off directly.

The LED display circuitry simply employs an LM3914 LED dot/bar-mode IC, operated in the dot mode here. This is partly to conserve battery current (prolonging battery life) and partly because it gives a much more convenient display in this application. It is arranged to read 0 - 1.25 V, according to the bias provided by R7. Only seven LEDs are used rather than the 10 possible, as the low scale one (pin 1) is inaccurate and rarely used, and the output from C4 provides 1 V at a relative humidity of 100% (thus the highest LEDs, pins 11 and 10, are unnecessary). The calibration graph in Figure 3 indicates at which levels each LED turns on and what $H_{rel.}$ each LED corresponds to.

Supply is derived from a 9 Vdc source and the supply rail for IC1 and IC2 is zener regulated to 4.7 V.

## PARTS LIST — ETI 256

**Resistors** all ½W, 5%
- R1, R2 ..... 470k
- R3 ..... 4k7
- R4 ..... 22k
- R5 ..... 4M7
- R6 ..... 390R
- R7 ..... 1k
- RV1 ..... 10k miniature trimpot

**Capacitors**
- C1, C2 ..... 47p ceramic (see text)
- C3 ..... 10u/16 V tantalum
- C4 ..... 100n greencap
- CV1 ..... 2-40p film or ceramic trimmer

**Semiconductors**
- IC1, IC2 ..... 4001
- IC3 ..... LM3914
- LED1-7 ..... TIL220R or any suitable LED
- D1 ..... 1N914, 1N4148 silicon diode
- ZD1 ..... 400 mW or 1 W zener, see text

**Miscellaneous**
- H1 ..... Philips humidity sensor type 2322 691 90001

ETI-256 pc board, pushbutton switch (momentary action); battery clip to suit No. 216 9 V battery.

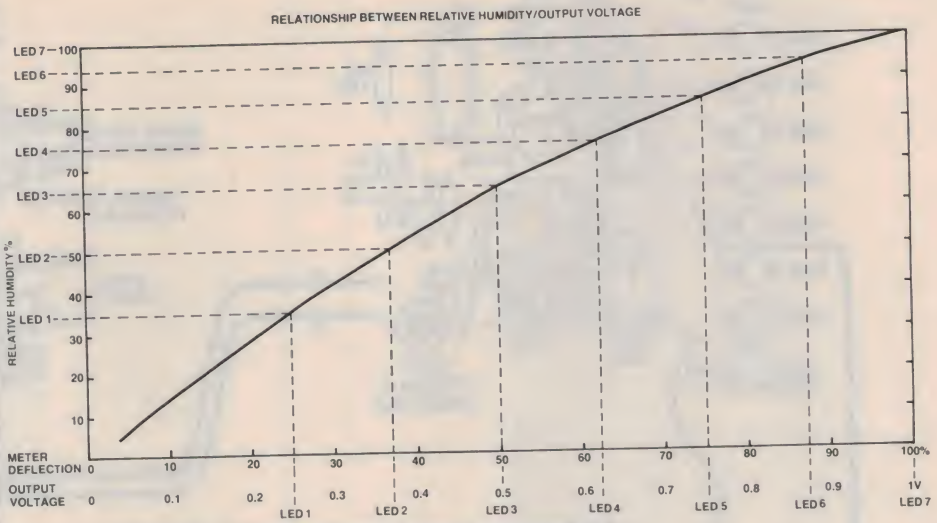



*Figure 3.* **LED display and humidity readings against meter deflection.**

read at a glance. The indication is somewhat non-linear; that is, the interval between each LED is not the same, as the linearising circuit is not perfect. The interval decreases with increasing humidity. Between LED1 and LED2, the change indicated in relative humidity is 15%, from 35% to 50%. At the opposite end of the scale, the change indicated in relative humidity between LED5 and LED6 is less than 10%. The reading indicated by LED6 is only accurate to a few per cent in any case. If you want to read the humidity to within 5% over most of the range between 10% and 90%, we suggest you opt for a meter readout. A calibration graph is given in Figure 3. To employ the project as part of an automatic environment control system, the LED readout circuitry is necessary.

Our prototype operates from a No. 216 9 V battery. To conserve battery life, we used a pushbutton switch to operate the unit, and the reading stabilises very shortly after the circuit is switched on.

## Construction

The unit is quite easy to assemble. We've not given any details of housing the completed project as this is likely to vary widely according to individual requirements. Generally, the components may be assembled in any order. Take care with the orientation of the three ICs, the LEDs, C3 and the two diodes, D1 and ZD1. The humidity sensor is not polarised and may be connected any way round. Solder its leads quickly to avoid affecting its performance. The photograph of our unit shows the sensor mounted on the pc board, but we did this principally for convenience. It can be mounted off the board but it is necessary to keep the leads short and ensure they have little capacitance. We would recommend you mount the sensor no more than about 50 or 60 mm away from the pc board and use 22 gauge tinned copper wire spaced the width of the sensor's pins apart (about 5 mm). A twisted pair of hookup wire is not recommended.

If the unit is to be used in a very humid environment (in a hothouse, for example), mount the electronics in a sealed box with the sensor mounted externally, and pass the sensor's pins through a hole in the box, sealing the box with Silastic or a similar sealing compound so that the humid atmosphere does not affect the electronics.

Note that positive temperature coefficient (PTC) capacitors are specified for C1 and C2. *No substitutes can be made* without adversely affecting the operation of the instrument. We have given Philips part numbers but other manufacturers do make PTC ceramic capacitors. It is necessary to ensure you purchase capacitors having a positive temperature coefficient of 100 parts per million (i.e: P100) of the nominal capacitance specified (47 pF).

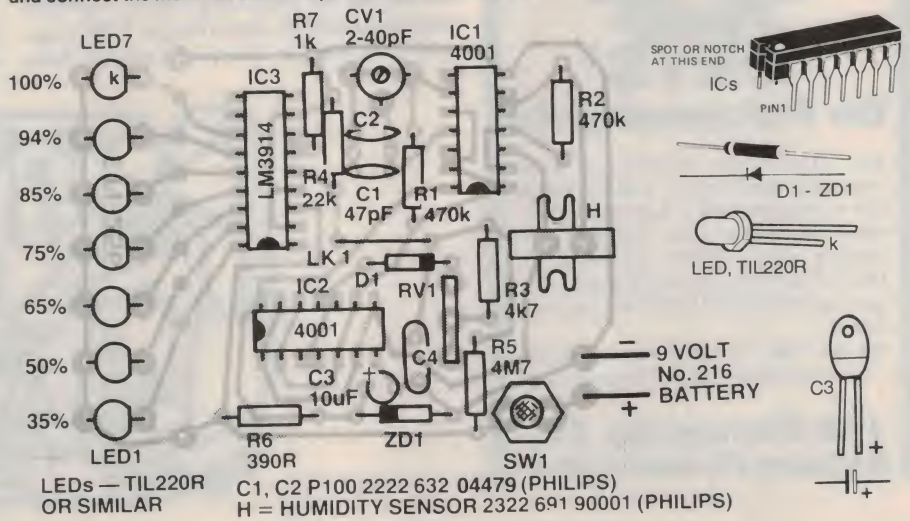
## Alignment

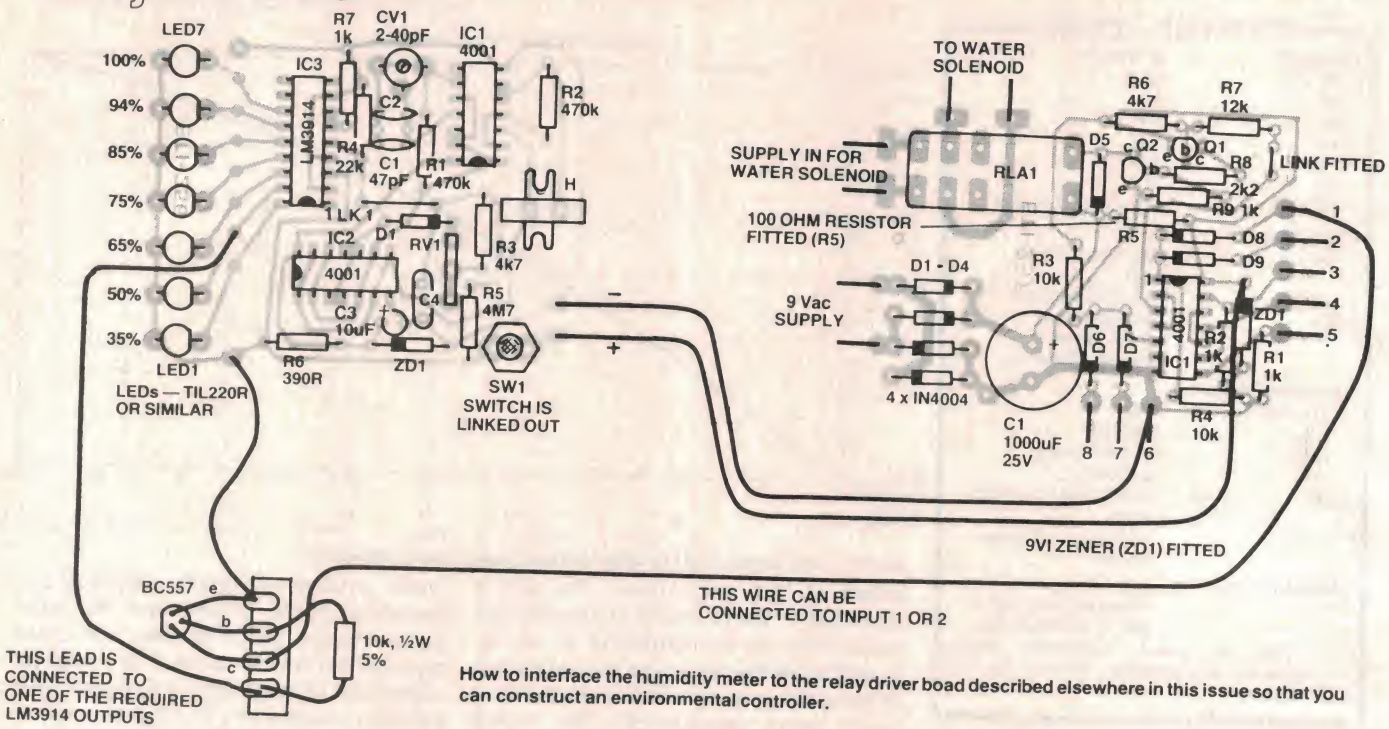
To obtain optimum performance, the following adjustment procedure is recommended:

If you are using the LED display, connect a high impedance voltmeter (input impedance of 1M or greater) between pin 5 of the LM3914 (IC3) and 0 V. Set RV1 at minimum resistance.

1) Replace the humidity sensor by a combination of capacitors to make up a value of 118 pF (a 100 pF, 15 pF and 3p3 in parallel). Turn the unit on and adjust CV1 to produce minimum out-

**Component overlay. If you want meter readout, leave out IC3, the LEDs and R7, put R4 in place of Link 1 and connect the meter between the pin 5 pad of IC3 (+) and 0 V.**






**How to interface the humidity meter to the relay driver boad described elsewhere in this issue so that you can construct an environmental controller.**

put. You should be able to get this down to about 0.09 V (90 mV). A slight zero offset reading occurs due to the current supplied by R5. Turn the unit off after adjustment.

2) Replace the 118 pF capacitor network substituted for the sensor by one of 160 pF (150p and 10p in parallel). Turn the unit on again and adjust RV1 to produce a reading of one volt on your voltmeter. LED7 should light.

If you are using a 50 uA meter for readout instead of the LM3914 and LEDs, repeat steps (1) and (2), but this time connect your high impedance voltmeter across C4. In step (2) adjust for full-scale deflection on the meter.

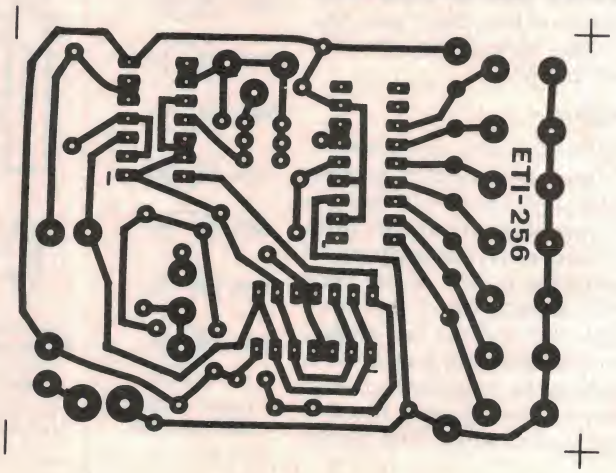
## As a controller

The humidity meter can be used as a controller in conjunction with the ETI-257 Universal Relay Driver Board described elsewhere in this issue. It is necessary to use the LED display version of the humidity meter. A simple interface circuit, involving a PNP transistor, is used to derive an output from one of the LEDs on the humidity controller and drive a 'pull high to operate' input on the ETI-257 relay driver board. The accompanying diagram shows how it's done.

The switch on the humidity controller board is not used and the pads on the board are linked. A BC557 is mounted on a tagstrip, along with a 10k, ½W resistor, and this provides the interface between the humidity meter and relay driver boards. The appropriate humidity level is selected by connecting a lead from the cathode of the appropriate LED to the base of the interface transistor, via the 10k resistor.

Power supply for the humidity sensor is obtained from the relay driver board. Don't forget to install Link 1 on the latter board.

In this application the sensor should be placed so that it takes a reading unaffected by the source of water vapour.●



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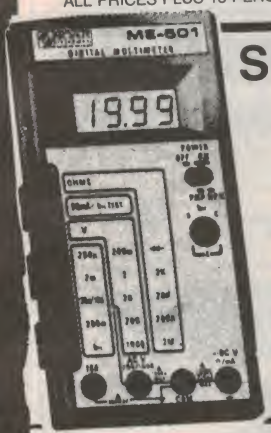


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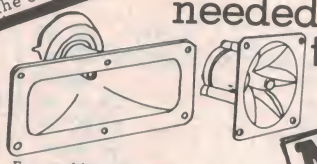

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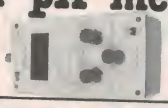

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Project 257

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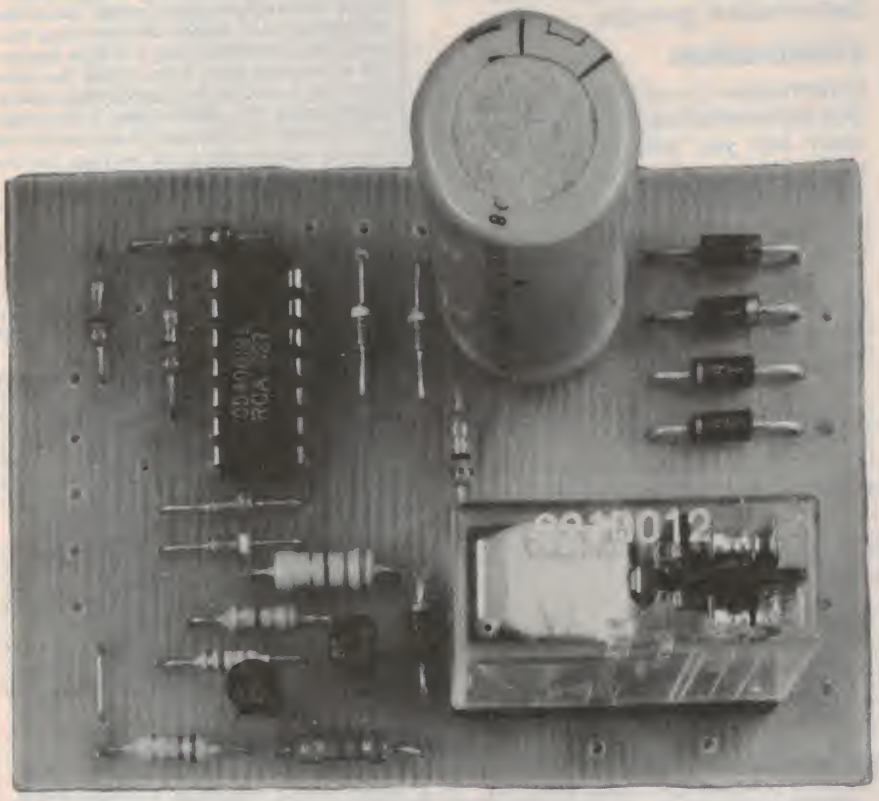
**Graeme Teesdale**

THIS VERSATILE relay driver unit is intended to be used with projects or devices not normally providing a switched relay output. In addition, power for external circuitry can be obtained from the board.

The unit has three groups of 'logic' inputs and a direct input. The relay itself is driven by two transistors, Q1 and Q2, and the direct input goes to the base of Q1 via a resistor (R7). Linking this input to the unit's 0 V rails — via a switch, a transistor which is turned on by a signal (open-collector logic) or a logic gate output — will operate the relay.

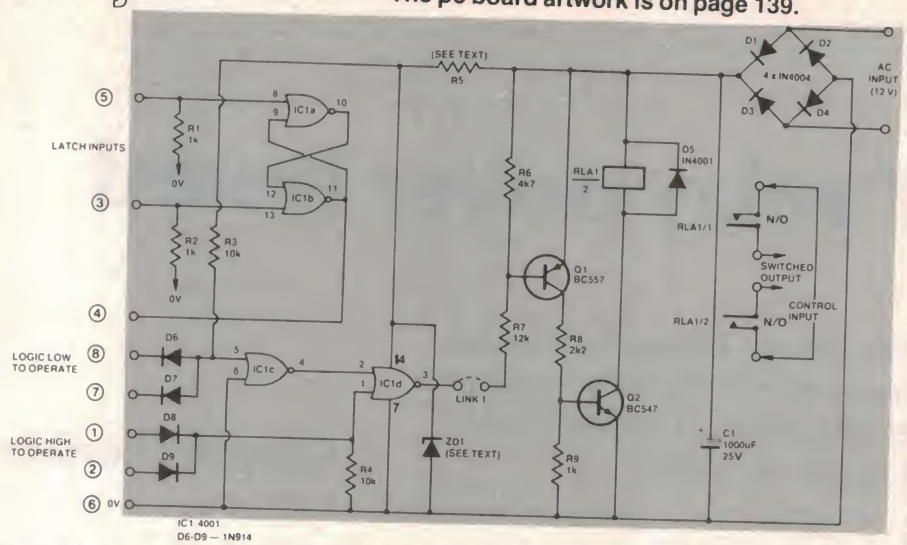
The logic circuitry on the board can be implemented by installing Link 1, which connects the output of the logic circuitry to the direct input. There are two "logic high to operate" inputs (pins 1 and 2). A logic high level — i.e: voltage level above about 2 V — on either of these inputs will operate the relay. There are also two "logic low to operate" inputs (pins 7 and 8). Pulling either of these inputs below logic low — about ▶



The relay driver board is simple, yet versatile. The external input/output pins are located around the edges of the board.

# Project 257

The pc board artwork is on page 139.




**Circuit diagram of the relay driver board. Note that the rectifier diodes may be any of a range of types, such as 1N4001-2-4, etc, or EM401, EM402, etc. A variety of common relays will fit the pc board.**

0.5 V — will operate the relay. Note that these input pairs are ORed with diodes and can be linked so that one input inhibits the other. In addition there are two "latch" inputs, pins 3 and 5. Pin 4 is the output of the latch circuitry and latch operation is implemented by linking this pin to one of the other inputs. All the logic inputs are high impedance and can be driven from CMOS circuitry.

This unit is powered from a 12 to 15 Vac source such as a plugpack or 5 VA transformer. Supply for IC1 (and perhaps any off-board circuitry) is obtained from a simple zener regulator circuit. This can be chosen to suit individual requirements. We used a BZY96/8V2 zener (1N4738) to provide an 8.2 V rail for IC1. We used a 220 ohm, 1 W resistor for R5. You can use any convenient zener from 5.1 V to 15 V — but no higher, and we recommend 1 W types run at around 50-60 mA current. You will have to work out the value of R5 according to your choice of zener. For a 15 V zener, R5 could be 47 ohms, for a 5.1 V zener, 270 ohms, or for a 12 V zener, say 100 ohms. There's plenty of latitude and these values are only given as a guide.

The logic circuitry (i.e: IC1) can be supplied from an off-board source if you wish. To do so, remove R5 and use a 15 V zener for ZD1 to prevent spikes on the external supply line causing damage to IC1. Note also that the logic levels on inputs 1, 2, 3 and 5 should also be no higher than 15 V.

The accompanying drawings illustrate how the unit is used in its four basic modes of operation.

## Construction

Construction is very straightforward. The components may be mounted in any order but you will probably find it easiest to leave the relay and C1 until last. Watch the polarity of all the diodes, the transistors and the IC. However, leave out link 1 at this stage.

Once you've got it together and have checked everything, apply 12 V ac to the ac input and check various modes of operation as follows:

(1) Bridge the free end of R7 to ground. The relay should operate.
(2) Install link 1, then bridge pin 7 to ground. The relay should operate.
Likewise for pin 8.
(3) Bridge pin 1 to the cathode of the zener. The relay should operate. Likewise for pin 2.
(4) Connect pin 4 to pin 1 or 2. The relay may operate. Apply a pulse to pin 3 or 5 and see that it latches on. A pulse on the other input will drop it out again.

If all is well, your unit is ready for installation! ●

### PARTS LIST — ETI 257

**Resistors** — all ½W, 5% unless noted

| | |
|---|---|
| R1, R2, R9 | 1k |
| R3, R4 | 10k |
| R5 | 220R, 1W (see text) |
| R6 | 4k7 |
| R7 | 12k |
| R8 | 2k2 |

**Capacitors**

| | |
|---|---|
| C1 | 1000 u/25 V electrolytic |

**Semiconductors**

| | |
|---|---|
| IC1 | 4001B |
| Q1 | BC557 |
| Q2 | BC547 |
| D1-D5 | 1N4001, 1N4002 etc |
| D6-D9 | 1N914, 1N4148 etc |
| ZD1 | 400 mW or 1 W zener, see text |

**Miscellaneous**

ETI-257 pc board; RLA1 — relay, Fujitsu FRL-621D012 or Takamisawa VB 12STAN or Pye 265/12/G2V.

### HOW IT WORKS — ETI 257

The best place to start is right in the middle of the circuit — because that's the 'business' end!

Transistor Q2 has relay RLA1 as its collector load. Diode D5 provides protection for Q2 when the coil current is cut off whenever Q2 is turned off. The base of Q2 is driven by the collector of Q1 via R8 and R9. Base bias for Q1 is obtained from the resistor network of R6 and R7. The 'free' end of R7 can be linked to on-board logic circuitry (IC1) or driven by an external source.

If the free end of R7 is connected to 0 V then base current will flow in Q1, which will turn on. This will turn on Q2 and the relay will operate. In fact, all that is required to turn Q1 on is to 'pull' the free end of R7 about 1 V below the positive supply rail to overcome the 0.6 V base-emitter turn-on voltage of Q1.

Effectively, a 'low' level on the free end of R7 will operate the relay.

Two groups of logic circuitry built around IC1 are included to provide a variety of operating 'modes'. IC1 is a quad NOR gate package. One gate, IC1d, is arranged to provide a 'logic high to operate' mode. Two diodes connected as a simple OR gate have their cathodes connected to pin 1 of IC1d. The output of another gate, IC1c, drives the other input, pin 2, of IC1d. IC1c has one input (pin 6) connected to 0 V, which is thus held at logic low. Pin 5 IC1c is held at logic high by R3 and thus its output, pin 4, will be high. As this drives pin 2 IC1d its output, pin 3, will be high. With Link 1 fitted, Q1 will normally be off and the relay not operated.

When a high logic level is applied to either input pin 1 or 2, or both, the diode(s) will conduct driving pin 1 IC1d high. The output, pin 3, will go low and the relay will operate. The relay will remain operated only while the input remains high.

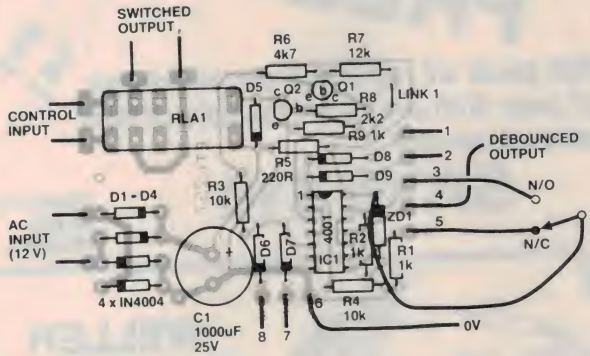
Two diodes (D6, D7) are connected as a simple OR gate with their anodes connected to pin 5 IC1c. A logic low on either input pin 7 or 8 ('logic low to operate') or both will pull pin 5 IC1c low and its output, pin 4, will go low. Pin 2 IC1d will go low and thus pin 3 IC1d will go low and the relay will operate. The relay will remain operated only while the input remains low.

The remaining two gates from IC1 are connected as a set-reset (SR) flip-flop. Pin 4 on the pc board provides an output which may be coupled to the other inputs. Assume the SR flip output is initially low. A pulse applied to input pin 3 or 5 will cause pin 4 (pins 9, 11 of IC1a, b) to 'latch' high. A pulse then applied to the opposite input pin will cause the output to go low again, and remain low.

This part of the circuit can be used as a 'switch debouncer' as illustrated.

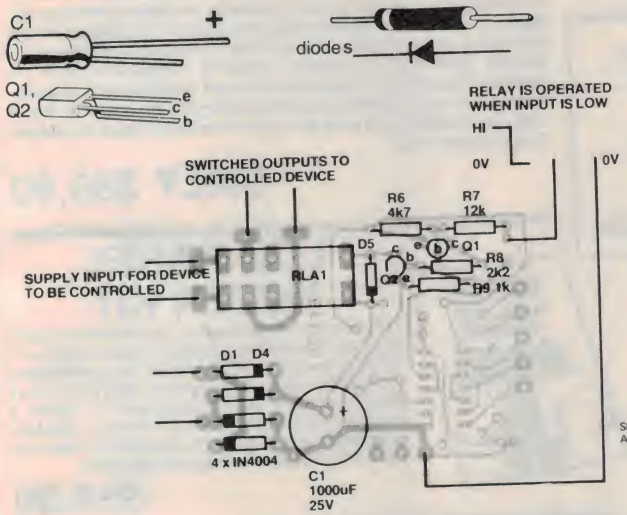
Power is derived from an off-board 9 Vac or 12 Vac source. This drives a bridge rectifier, diodes D1 to D4, smoothing being provided by C1. A zener diode, ZD1, is used to provide a regulated supply to the logic circuitry (IC1).

# universal relay driver



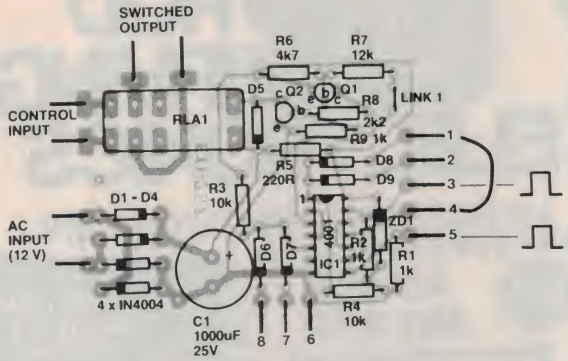

## SWITCH DEBOUNCING

The SR flip-flop (IC1a and b) is not electrically connected to the rest of the circuit and may be used in external circuitry — for example, as a switch debouncing circuit.



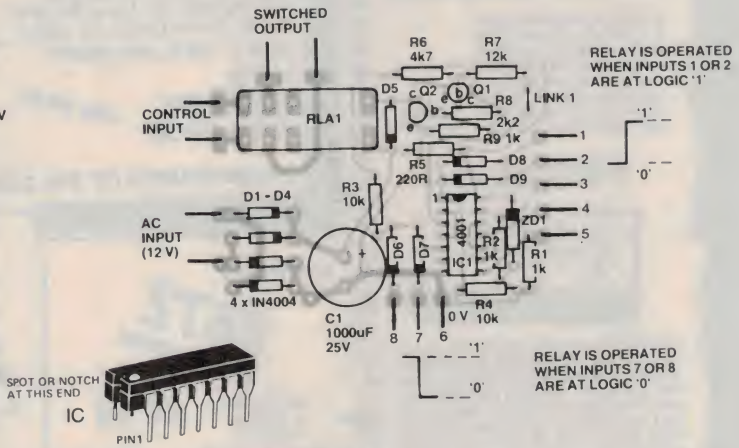

## DIRECT INPUT

The relay will operate when the input is low (i.e: 0 V) or 'pulled' about 1 V lower than the positive supply rail. Only those components shown are necessary for this mode of operation.




## LATCH OPERATION

Pin 4, the output of the set-reset (SR) flip-flop, must be linked to either pin 1 or pin 2, or pins 7 or 8. A positive-going pulse on pin 3 or pin 5 will cause the relay to latch. A positive-going pulse on the opposite latch input will then cause the relay to unlatch.




## LOW OR HIGH TO OPERATE

The relay will be operated when pins 1 or 2 are held at logic high. To operate the relay from a logic low, pins 7 or 8 must be held at logic low. The inputs are ORed so that up to two input signals can be employed to operate the relay in each mode.

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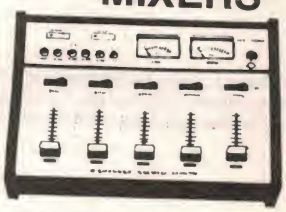

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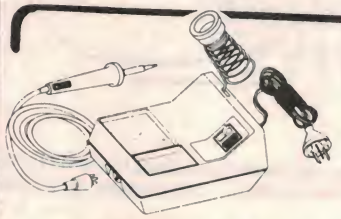

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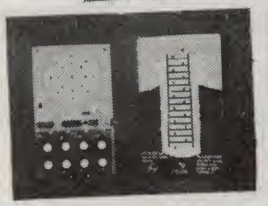

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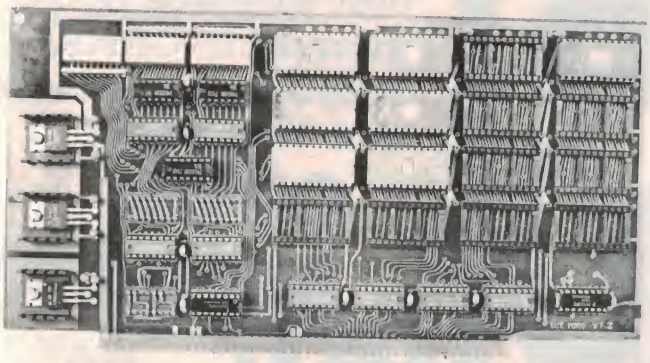

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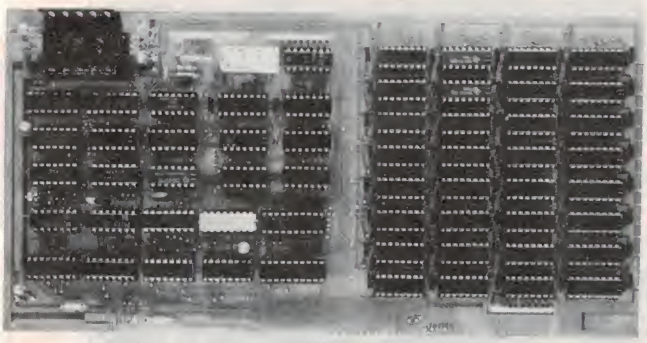

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# Lab Notes

# Gate, square, sine, modulate — with the 555 & 7555.

**Ray Marston**

The ubiquitous 555 timer chip, or its modern CMOS counterpart the 7555, can be readily used as a highly stable and cost-effective astable multivibrator. Although often used just as a square wave generator, they're capable of performing some fairly fancy tricks.

THE OLD-FASHIONED 555 IC should be a fairly familiar component to the average hobbyist. It's the 'universal' square wave generator, pulser, gate and timer. But really, it's much more than that if you employ a little ingenuity in circuit design. The modern CMOS version, the 7555, is even more versatile than its predecessor. Apart from a wide variety of gating functions, the 555/7555 can perform tricks like ramp and sine waveform generation.

## Astable gate

The 555/7555 astable can be gated on and off in a variety of ways, to produce different output waveforms. Figure 1 shows the basic connections and the equivalent circuit of the standard 555/7555 astable. It is necessary to understand the operation of this basic circuit in order to appreciate the action of the various gating methods. In the following discussions, a 12 V supply rail is assumed in all circuits.

The first point to note about the Figure 1 equivalent circuit is that the IC contains a three-resistor potential divider, two voltage comparators, a flip-flop, a transistor and an output buffer.

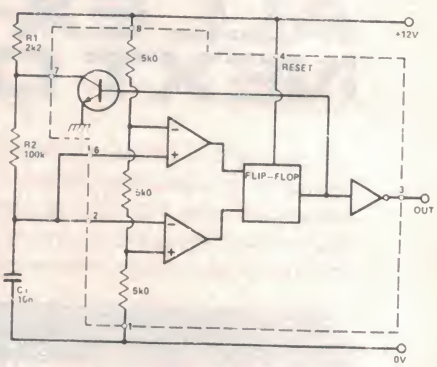



*Figure 1b.* **Equivalent circuit of the 555-type astable multivibrator.**

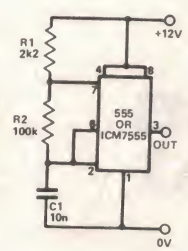



*Figure 1a.* **Basic circuit of the 555-type astable multivibrator.**

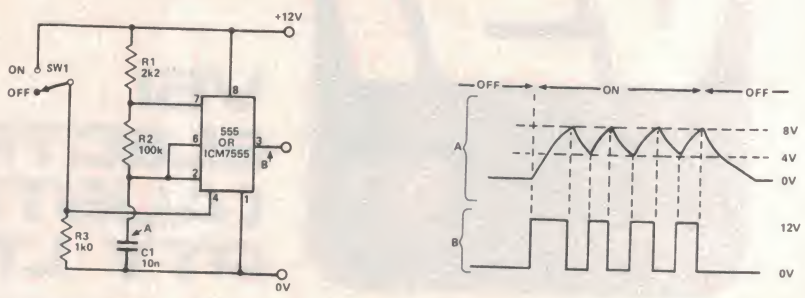



*Figure 2.* **Conventional way of gating the 555 astable, with resultant waveforms.**

The divider ratios are such that one-third of the supply voltage (i.e: 4 V) is set on the lower comparator and two-thirds of the supply voltage (i.e: 8 V) is set on the upper comparator. The circuit action is such that, in each operating cycle, C1 first charges up to 8 V through R1-R2, at which point the upper comparator activates the flip-flop and turns the internal transistor on; the transistor then discharges C1 through R2 until the C1 voltage falls to 4 V, at which point the lower comparator activates the flip-flop and turns the internal transistor off, causing C1 to recharge through R1-R2. The operating cycle is then complete and repeats ad infinitum. A ramp waveform with an amplitude that swings between 4 V and 8 V is generated across C1 and a rectangular waveform is generated at the output, pin 3.

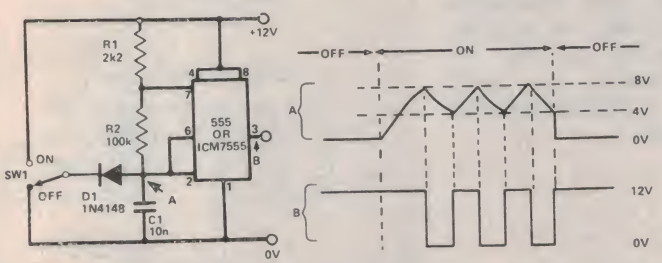



*Figure 3.* **Basic method of gating the 555 astable using C1, with resultant waveforms. Note that the period of the first half-cycle is longer than that of the succeeding half-cycles.**

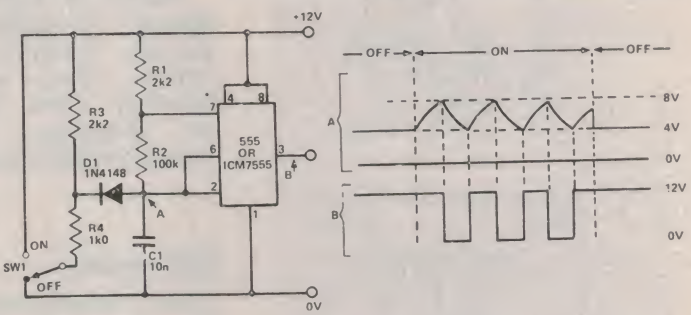



*Figure 4.* **Modification of the C1 gating scheme, giving constant-period half-cycles.**

The conventional way of gating the 555/7555 astable is with the pin 4 reset terminal, as shown in Figure 2. When this pin is pulled to ground (by a 1k resistor), the flip-flop output is driven high, thus discharging C1 through R2 and the transistor and also driving the output (pin 3) low. The resulting circuit waveforms are shown in the diagram. Note that, when the astable is gated on, the first half cycle is considerably longer than the succeeding half cycles. Also note that, when the astable is first gated off, the voltage across C1 takes a substantial time to decay to zero. The output is zero during the off condition.

## Alternative methods

One alternative method of gating the 555/7555 is shown in Figure 3. Here, when the circuit is gated on, D1 is back-biased and the astable operates in the normal way, but when the circuit is gated off D1 shorts out C1 and pulls point A to ground; in practice, of course, SW1 can be replaced by an electronic switching waveform (the output of a CMOS gate, etc). Note in this circuit that, when the astable is gated on, the first half cycle is again considerably longer than the succeeding half cycles, but that the C1 voltage falls abruptly to zero at gate-off. Also note that the output is high in the off state, here.

Figure 4 shows how the above circuit can be modified so that the duration of the first half cycle is almost equal to that of the succeeding half cycles. This is achieved by choosing the R3-R4 values so that the voltage across C1 is only a fraction below 4 V (one-third of supply volts) during the off condition. A substantially different set of waveforms can be obtained by choosing the R3-R4 values so that the voltage across C1 is a fraction below 8 V (two-thirds of supply volts) during the off condition, as shown in Figure 5.

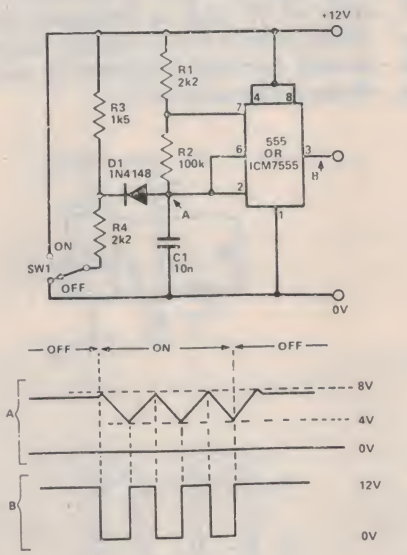



*Figure 5.* **This slight modification of the C1 gating scheme produces a considerable change in the circuit output waveforms.**

It should be appreciated that the 555/7555 astable can only oscillate if its timing capacitor (C1) is free to swing between the 4 V and 8 V switching levels. This simple fact makes it possible to voltage-gate the astable by using the circuit of Figure 6. Here, the circuit produces output waveforms only when the input voltage exceeds 8 V. The circuit can be made to trigger at other levels by giving the op-amp an appropriate voltage gain factor.

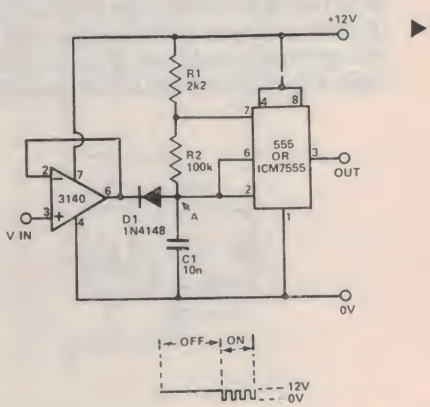



*Figure 6.* **The voltage-controlled astable produces an output only when $V_{in}$ exceeds two-thirds supply (8 V in this example).**

# Lab Notes

Finally, an alternative method of gating the 555/7555 astable is shown in Figure 7. Here, the circuit is gated off by driving the voltage across C1 above 8 V by D1. A feature of this circuit is that its 'B' output is low in the off condition.

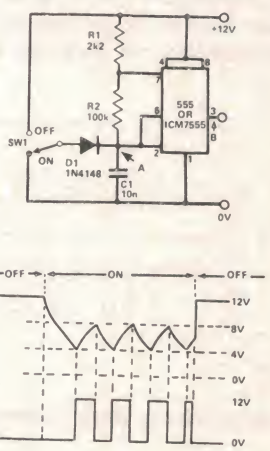



*Figure 7.* **This C1 gating scheme produces a 'B' output that is low in the off condition.**

## Asymmetrical astables

The basic 555/7555 astable generates near-symmetrical output waveforms, provided that R2 is large relative to R1 (giving near-equal C1 charge and discharge time constants). Figures 8 to 10 show alternative methods of generating non-symmetrical waveforms. In Figure 8, C1 charges through R1-R2 but discharges through R2 in parallel with R3-D1, to produce the waveforms shown. In Figure 9, C1 charges through R1 and R2 in parallel with R3-D1, but discharges through R2 only; this circuit is useful for providing narrow output pulses at the 'B' terminal.

Finally, in Figure 10, C1 charges through R1-R3-D2 and discharges through D1-RV1-R1-R2, to produce narrow output pulses at the 'B' terminal. This circuit is useful for generating variable-frequency constant-width pulses.

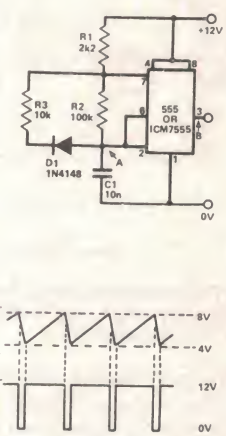



*Figure 8.* **A method of producing a non-symmetrical fixed ratio from the 555 astable.**

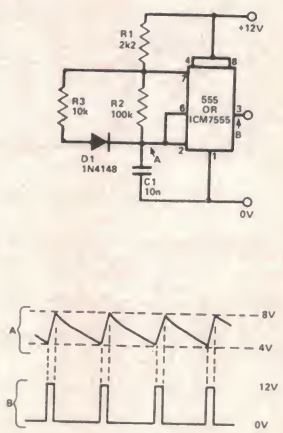



*Figure 9.* **Alternative method of producing a non-symmetrical fixed ratio output from the 555 astable.**

## Sine waves

Figure 11 shows how a sine wave signal can be obtained from a 555/7555 astable. Here, the symmetrical ramp waveform of C2 is buffered by Q1 and then ac coupled to the R1-R2-D1-D2 divider/limiter network. This network attenuates the ramp signal and then non-linearly removes the ramp's positive and negative peaks, to produce a sine-shaped waveform of about 1 V peak-to-peak amplitude at the output terminal. The distortion level of the resulting sine wave is typically of the order of 3% and its frequency can be varied from a few cycles per minute to several hundred kilohertz by suitable choice of the value of C2.

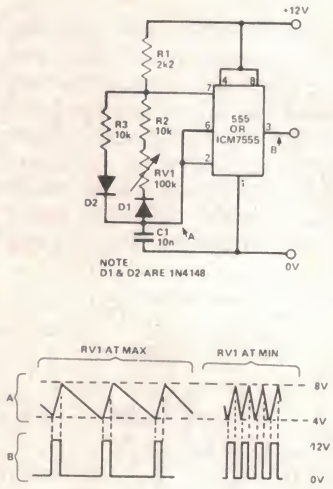



*Figure 10.* **A method of producing a non-symmetrical variable ratio output from the 555 astable.**

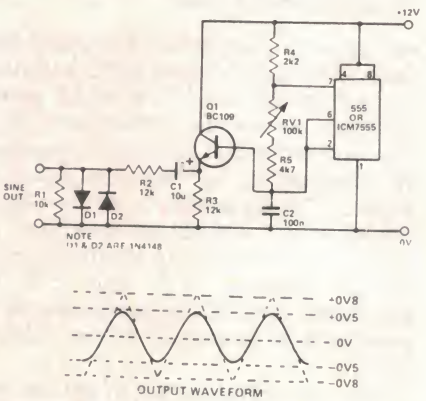


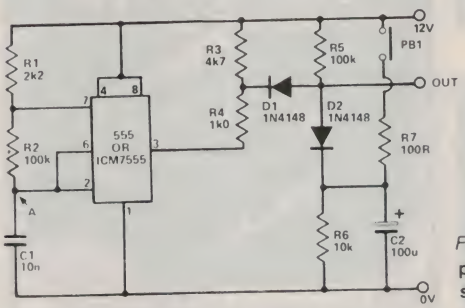

*Figure 11.* **A 555 sine wave generator with a range of 83 Hz to 1.4 kHz (via R1).**

## AM output

Figure 12 shows how the pin 3 square wave output of the 555/7555 astable can be amplitude-modulated to produce the typical attack-hold-decay envelope of a simple musical instrument or of a special-effects sound generator. The heart of the unit is the diode AND gate, or mixer, formed by D1-D2-R5. One input of this gate is fed from the output of the astable via R3-R4 and the other from across R6. The basic action of this gate is such that (ignoring the diode volt drops) its output amplitude is equal to the lesser of the two inputs.

Thus, when D1 is fed with the square wave output of the astable, the peak output of the unit will be zero when the voltage across R6 is zero, or 5 V when the voltage across R6 is 5 V, etc. In our circuit, R6 is shunted by electrolytic capacitor C2. Thus, when PB1 is pressed, a large voltage is applied to R6 and a large-amplitude square wave output is available. When PB1 is released, the voltage across R6 and the square wave output amplitude decay exponentially to zero (with a time constant of R6-C2), as shown in the diagram. The R3-R4 network is used to apply a slight offset bias to the rectangular input waveform, to ensure a full cut-off of the output waveform after PB1 is released.

Finally, Figure 13 shows how the above circuit can be modified to give extended delay times (via emitter follower Q1) and a buffered audio output (via emitter follower Q2). ●



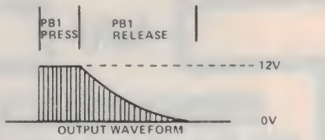




*Figure 12.* **A method of amplitude-modulating the pin 3 output off the 555 astable in music and sound generator applications.**

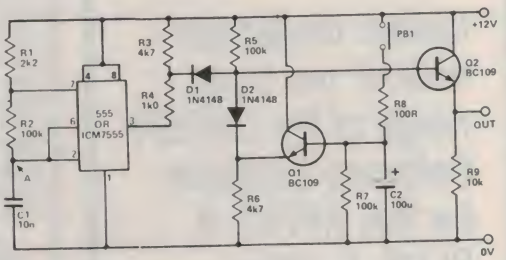



*Figure 13.* **A modification of the Figure 12 circuit to give extended decay times and a buffered output.**

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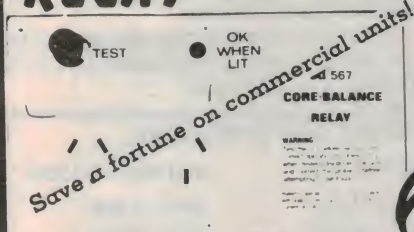


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# Ideas for Experimenters

**These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.**

**ERRATA**

**A rather obvious, but potentially dangerous error occurred in the circuit on the top left of page 60 ('Power Monitor') in the March issue. It shows the mains active input connected to the earth at the output. The mains active input should instead go to the fuse. Correct your copy now. Correction slips were inserted in the majority of copies distributed.**

## Simple anemometer

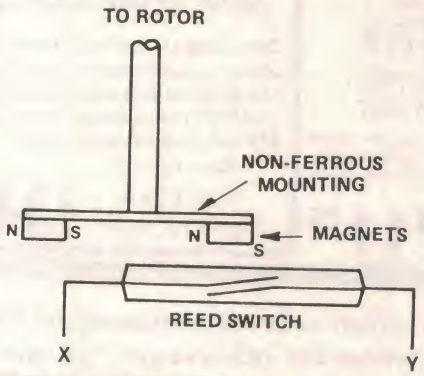
Having managed to pronounce the heading (an-ee-mom-meter), no doubt you're wondering what it is. It's a wind speed indicator.

The idea comes from 14-year-old **Wayne Brown of Dromana in Victoria.** Make up an anemometer rotor and attach two small magnets to a mounting on the bottom. A reed switch is then placed under this assembly such that the two magnets operate the reed switch twice per revolution of the rotor shaft.

The reed switch gates on and off a 555, the output of which is rectified and integrated to drive a meter (M1). You can use a meter having a sensitivity up to 150 microamps, but the resistor in series with the 1N914 will have to be selected to suit.

To calibrate it, you will need:
one daring passenger
one car
plenty of road
no radar traps.

With the anemometer's rotor held outside the vehicle (clamped to a roof rack, for example), drive at a variety of speeds for a short distance at each speed. The passenger can then mark down the meter reading against the car's speed so that the meter scale can be later marked with the calibrations.




## The ETI-480 amp module — barefoot and bridged.

For many years now, constructors have built the ever-reliable ETI-480 power amp and many people in the industry have used this design in many different ways. Some other variations that have been tried from time to time are listed in the table here, compiled by **G.T. Dicker of Parkholme, S.A.**

One of the most useful ways to utilise the ETI-480 is by bridging the output stage for increased power into higher load impedances.

This may be done with the 2N3055/2N2955 output stage combination or by utilising the MJ802/MJ4502 or MJ15004/MJ15003 type transistors in their place.

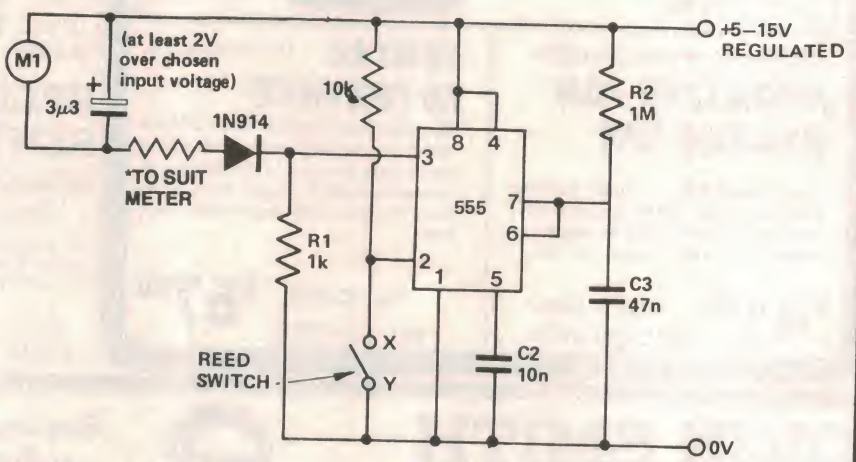
To bridge two modules, one must first get the modules working to specification, then add a 10k, ½W resistor from the junction of R8 and R9 on module 2 to the output stage, junction of R22 and R21 on module 1. Audio input is then provided to module 1 and output is taken from module 1 and 2 output stages. The input to module 2 may optionally be shorted but in practice makes little difference.

If you feel some of the options tabled look attractive wait and see what will be done with the ETI 466!

**ETI-480 TABLE OF OUTPUT POWER FOR VARIOUS CONFIGURATIONS**

| Supply Voltage | 3055/2955 | MJ802/4502 | MJ15003/MJ15004 |
|---|---|---|---|
| ±30 Vdc single-ended | 35 W - 8 ohm<br>65 W - 4 ohm | 35 W - 8 ohm<br>65 W - 4 ohm | 35 W - 8 ohm<br>65 W - 4 ohm<br>100 W - 2 ohm |
| ±45 Vdc single-ended | 65 W - 8 ohm | 100 W - 8 ohm<br>150 W - 4 ohm* | 100 W - 8 ohm<br>190 W - 4 ohm<br>300 W - 2 ohm* |
| ±30 Vdc bridge | 150 W - 8 ohm*<br>75 W - 16 ohm | 150 W - 8 ohm<br>75 W - 4 ohm | 150 W - 8 ohm<br>190 W - 4 ohm |
| ±45 Vdc | 100 W - 32 ohm | 190 W - 16 ohm | 195 W - 16 ohm<br>355 W - 8 ohm* |

*NOTES: Not recommended, unless for home hi-fi.
At output powers above 100 W RMS extreme heatsinking and/or forced air cooling is recommended.
Not all configurations are necessarily safe for continuous output power operation.
When MJ802/MJ4502 or MJ15003/MJ15004 are used supply fuses F1, F2 must be changed to 5 amps.



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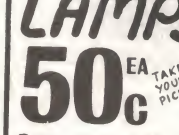

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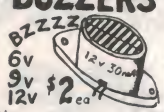


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| IN5408 | 1Kv 3A rect. | 40c | 32c | 25c |
| IN914/IN4148 | diode | 10c | 8c | 6c |
| RED LED | small 3mm | 20c | 16c | 12c |
| RED LED | std. 5mm | 15c | 12c | 10c |
| GREEN LED | std 5mm | 25c | 20c | 16c |
| ORANGE LED | std 5mm | 35c | 30c | 23c |
| LM380 | 2watt IC | $1.50 | $1.30 | $1.20 |

FEW ONLY! LM340T-12 (7812) 12v 1A REG. $1 EA 10+ 90c

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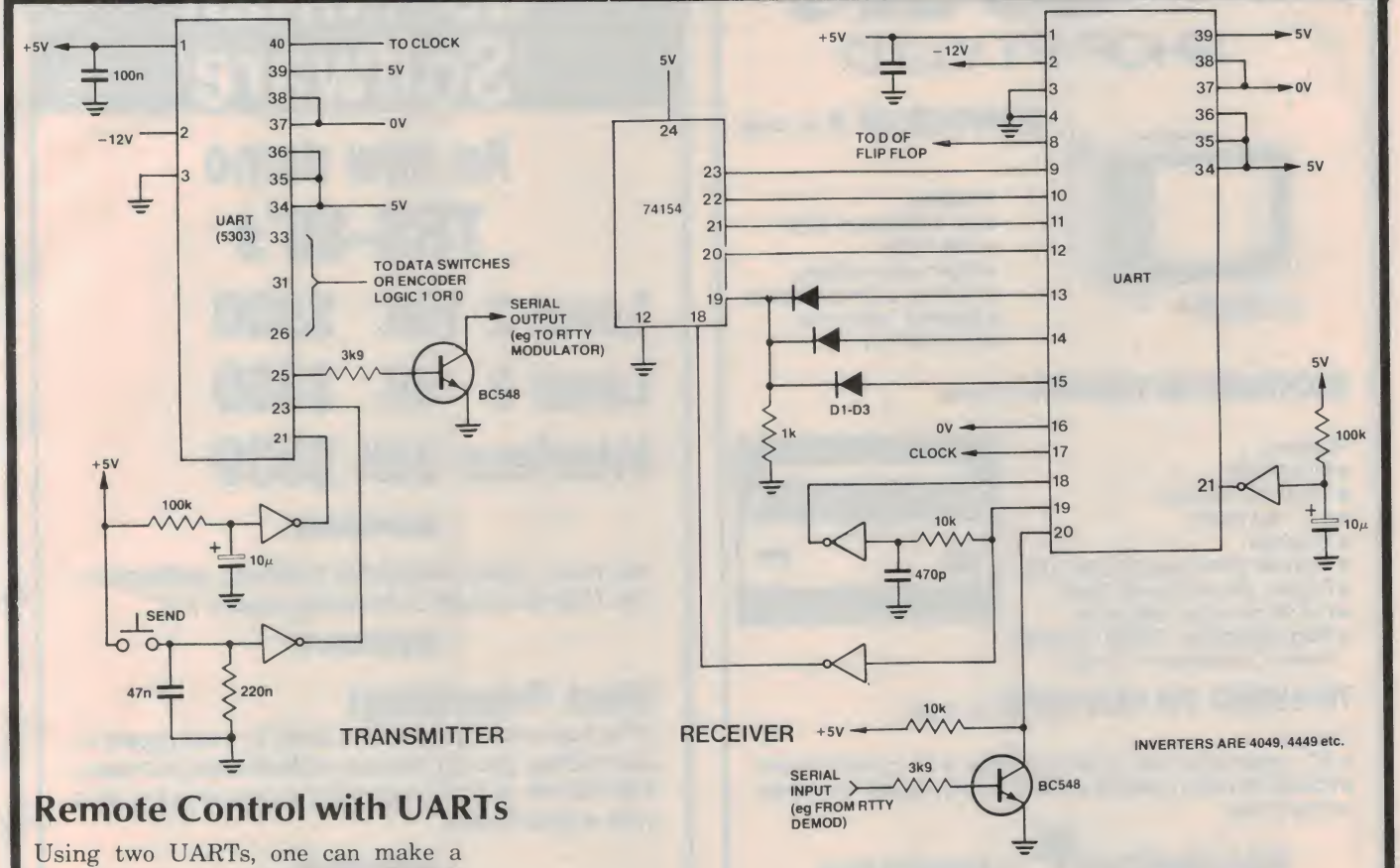
# Ideas for Experimenters




## Remote Control with UARTs

Using two UARTs, one can make a simple remote control system as **Ralph Youie of Oakleigh in Victoria** shows here. One UART is used as the transmitter and sends a binary word of, say, five bits. This word may be transmitted by radio, ultrasonics, infra-red etc. The receiver then converts the serial data into parallel data which can be decoded by logic devices, such as a 4-16 line decoder (74154). Each output of this decoder can be connected to the clock input of a 'D' type flip-flop, and the fifth bit can be connected to the 'D' input. Thus, a five-bit word programmed on the transmitter can control 16 flip-flops and hence 16 devices in two states. With a little more logic, one could control 16 devices in 16 states, 128 devices in two states, 64 devices in four states etc., using eight-bit words.

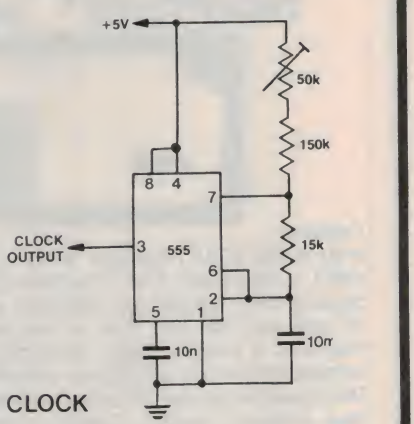
The circuit shown is just one possibility as many factors could be changed, such as clock rate, modulation system, word size, parity and transmission method to name a few. In the circuit, D1-D3 form an OR-gate which prevents the 74154 from operating if an error is found in the word received. Ralph used an RTTY system for the mod-demod and slide switches to program the code word on the transmitter. However, a refined system could use a keypad with encoder.

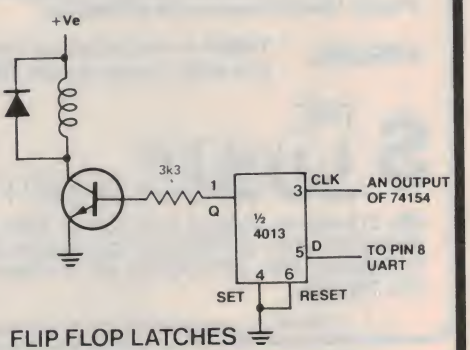
Possibilities include remote control of television, hi-fi, solenoid tape decks, lights, garage doors etc . . . limited only by imagination.

**UART pin connections:**

| | | | | |
|---|---|---|---|---|
| 1: Vss | 2: Vgg | 3: Vdd | 4: RDE | 5: RD 7 |
| 6: RD 6 | 7: RD 5 | 8: RD 4 | 9: RD 3 | 10: RD 2 |
| 11: RD 1 | 12: RD 0 | 13: RPE | 14: RFE | 15: ROR |
| 16: SWE | 17: RCP | 18: RDAR | 19: RDA | 20: RSI |
| 21: MR | 22: TBMI | 23: TDS | 24: TEOC | 25: TSO |
| 26: TD 0 | 27: TD 1 | 28: TD 2 | 29: TD 3 | 30: TD 4 |
| 31: TD 5 | 32: TD 6 | 33: TD 7 | 34: CS | 35: NPB |
| 36: NSB | 37: NDB 2 | 38: NBD 1 | 39: POE | 40: TCP |

**RDE** Receive Data Enable (tri-states data line)
**SWE** Status Word Enable
**RCP, TCP** clock input
**RPE, RFE, ROR** parity, frame, and receive overrun errors.
**MR** master reset
**NSB** 1 or 2 stop bits
**POE** odd or even parity
**RSI, TSO** serial input, output
**TDS** send transmit data
**NPB** parity inhibit
**NDB** no of data bit 5,6,7 or 8
**RDA, RDAR** Received data, Received data reset



# Don't let technology pass you by!

## Learn Microprocessor Programming and Application techniques with the HEATHKIT Microprocessor Self-Instruction Program.

If you're involved in scientific or electronic pursuits, microprocessors are becoming a way of life and a dominant factor in your success or failure. The EE-3401/ET-3400 self-learning program and accompanying computer trainer is the easy, effective way to learn about these powerful devices. The program uses Heath's proven self-instructional techniques including programmed instructions and audio-visual aids to teach computer programming, microprocessor operation, interfacing and related topics.

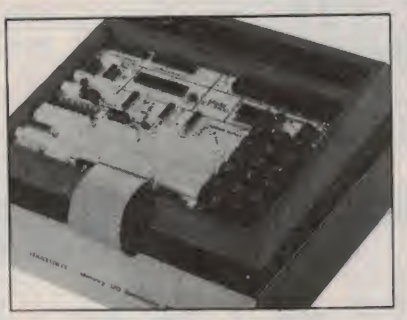
**This self-instruction program covers microprocessor basics, computer arithmetic, programming, interfacing and much more.**

The microprocessor course is organised into 10 learning units as follows: 1: Number Systems & Codes, 2: Microcomputer Basics, 3: Computer Arithmetic, 4: Introduction to Programming, 5: The 6800 Microprocessor—Part 1, 6: The 6800 Microprocessor—Part 2, 7: Interfacing—Part 1, 8: Interfacing—Part 2, 9: Programming Experiments, 10: Interfacing Experiments. Each unit is complete with introduction, unit objectives, activity guide, experiment, examination and examination answers.

The EE-3401 is complete with 62 electronic components required to complete the experiments. These components include two 2112 256 x 4-bit RAM's, 6820 PIA interface chip, 1406 d/a converter, 741 and 301 op amps and a variety of other microprocessor-oriented devices. The ET-3400 Computer Trainer is required for the experiments in the Microprocessor Course.

**Course EE-3401** **$155.00**

### Microprocessor Trainer for EE-3401 Program



Functioning as a miniature digital computer, the ET-3400 Microprocessor Trainer is essential for the experiments in the EE-3401 self-instruction program. After completing the program, the ET-3400 is ideal for breadboarding, prototyping and system design.

The ET-3400 features a built-in 1K ROM monitor program for controlling unit operation; 6-digit hexadecimal 7-segment LED display for address and data readout; 17-key hexadecimal keyboard for entering programs and data. Has 256 bytes of random access memory (RAM) built-in, expandable to 512 bytes with the RAM's supplied in the EE-3401 program. Also has 8 buffered binary LED's for display of breadboard logic states, 8 SPST DIP switches for binary input to breadboard circuits, a breadboarding socket for prototyping, interfacing and memory circuits.

All microprocessor address, control and data busses are buffered and terminated on the front panel for ease of connection to prototype circuits. There's also provision for a 40-pin external connector to extend memory and I/O capacity. Built-in +5, +12 and −12 volt power supplies.

**Kit ET-3400** **$347.00**

### Microprocessor Trainer Accessory

The ETA-3400 gives you the additional I/O and memory you need to turn your ET-3400 Microprocessor Trainer into a complete, personal computer system. It provides an audio cassette interface so you can store programs on convenient cassettes. It also provides an additional 1K bytes of memory so you can run longer and more sophisticated programs through the ET3400. The memory can be expanded to 4K bytes with the optional 3K chip set (ETA-3400-1). A serial I/O with EIA 20mA loop format provided in the ETA-3400 accessory lets you hookup a video terminal

A tiny BASIC interpreter is provided in ROM to let you do actual programming using the BASIC language.

**Kit ETA-3400** **$270.00**
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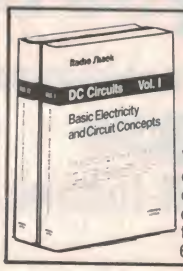
# What's The Advantage Of Having Tandy Electronics In Your Workshop?

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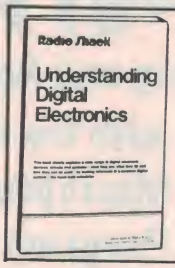


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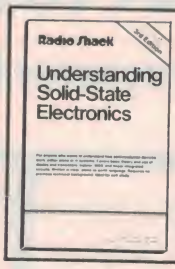


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| Heavy-Duty<br>Heavy-Duty<br>Heavy-Duty | 12.6CT<br>25.2CT<br>18CT | 3A<br>2A<br>4A | 6.9x5.7x5.0cm<br>6.9x5.7x5.0<br>10x5.0x6.3 | 273-9010<br>273-9011<br>273-9013 | 16.95<br>16.95<br>22.95 |
| Clock Module | 10/6/5 | 500mA | 5.2x2.8x3.4cm | 273-9530 | 9.95 |

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# Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project — check with our advertisers if it is not mentioned here.

First of all, readers requiring Scotchcal panels for the projects in this issue, or past projects of recent vintage, should enquire with Rod Irving Electronics and All Electronic Components in Melbourne and Radio Despatch Service in Sydney. Printed circuit boards for all this month's projects and almost every project we've done in the past can be supplied by (apart from specific suppliers mentioned) RCS Radio, 651 Forest Rd, Bexley NSW; Radio Despatch Service, 869 George St, Sydney NSW; and All Electronic Components, 118 Lonsdale St, Melbourne Vic.

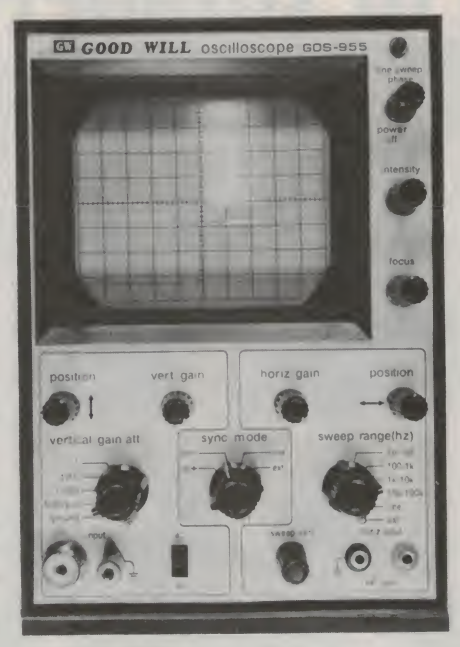
For subscribers in South East Asia we have news that Jemal Pty Ltd of Welshpool W.A., who stock most ETI pc boards and front panels, have appointed a distributor in Singapore. For your pc board and front panel requirements, contact Applied Digital Systems, 326 3rd Floor, Far East Shopping Centre, 546 Orchard Road, Singapore.

## ETI-735 UHF TV converter

The OM350 wideband amp chip used in the RF stage was also used last month in the ETI-729 Masthead Amp. So far as we were aware at time of going to press, the following suppliers were stocking the OM350: in Melbourne — All Electronic Components, Ellistronics, Rod Irving Electronics and Tasman Electronics; in Sydney — Jaycar and Radio Despatch Service. Dick Smith has it listed in his latest cataloguue as Z-6185.

For the tuneable version of the converter, there are two sources of suitable tuning capacitors, as mentioned in the article. The C1604 capacitor is sold by David Reid Electronics stores — get the 14 pF type. It costs around $7. The 15 pF Johnson capacitor is available from General Electronic Services of 99 Alexander St, Crows Nest NSW 2065. However, some kit suppliers may well be stocking this item, so check your favourite supplier first.

Note that this project requires a **fibreglass** pc board.




**Emona Enterprises, who recently gained the Good Will instruments agency, has released a 5" (130 mm) CRO featuring 6.5 MHz vertical amp bandwidth, 10 mV/div sensitivity, horizontal sweep from 10 Hz to 100 kHz, internal voltage and frequency calibration oscillator, and low cost. Called the Good Will GOS-955, it costs only $255 (plus tax). The two-tone front panel has large, clear markings for the controls and is well laid out. Vertical input connector is an SO239 socket. We found the unit easy to use, with good synchronisation and trace brightness. It held lock on signals well beyond the bandwidth and would be worth considering for the 'serious' hobbyist. We hear the latest shipment sports a 7 MHz bandwidth. See Emona, Suite 208/661 George St, Sydney NSW 2000. (02)212-4815.**

## ETI-256 humidity meter

This unique, versatile little project is built around the Philips capacitive humidity sensor type 2322 691 90001. This is distributed by Sycom (offices in Sydney and Melbourne). At the time of going to press Radio Despatch Service in Sydney and All Electronic Components in Melbourne said they would be stocking the humidity sensor.

The two 47 pF positive temperature coefficient capacitors (100 parts per million — P100) will also be stocked by these two firms. All other components are widely stocked.

## ETI-257 relay driver board

There's nothing out of the ordinary in this project and pc boards and components should be readily available. The board was laid out to accommodate the various popular double-pole relays available and you can fit the Fujitsu FRL621D012 (distributed by IRH Components), the Takamisawa VB 12STAN (distributed by Associated Controls) or the Pye 265/12/G2V.

## Series 5000 heatsink panels

At time of going to press, the following firms had ordered or had in stock the front panel/heatsink for the MOSFET amplifier presented in the January, February and March issues: in Sydney — Electronic Agencies and Jaycar; in Melbourne — All Electronic Components, Rod Irving Electronics and Tasman Electronics.

Readers may also order the unit through the magazine. The cost is $42.50, post paid within Australia. Send your cheque or money order to cover the number you require to:

**Series 5000 Heatsink/Front Panel**
**ETI Magazine**
**15 Boundary St**
**Rushcutters Bay NSW 2011**

Please allow up to four weeks for delivery.

## Project price estimates

As some information on component pricing and availability could not be obtained until very late, we have not included the price estimates with the projects this month. As this page is usually the last to be done, we've included it here. Note that these prices are estimates only and not recommended prices. A variety of factors may affect the price of a project, such as quality of components purchased, type of pc board (fibreglass or phenolic base, tinned tracks, etc), type of front panel (if used) supplied, etc — whether bought as a kit or separate components.

| | |
|---|---|
| ETI-735 UHF TV converter | |
| • single channel version | $35 - $40 |
| • tuneable version | $52 - $58 |
| (plug pack not included) | |
| ETI-256 humidity meter | $21 - $27 |
| ETI-257 relay driver | $10 - $12 |

# How many of these kids are equipped for the electronic world of tomorrow?


This century has seen remarkable advances in electronics. Advances which are now a part of every day living. As this continues into the next century, there will be the need for more education in electronics. A good basic knowledge of electronics is essential for those children who are to become our future technicians, programmers and so on. Without this knowledge, your child could be left in the dark, perhaps without a future career.
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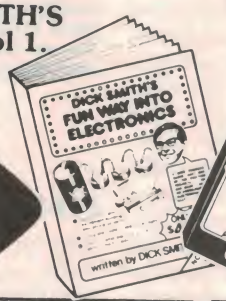



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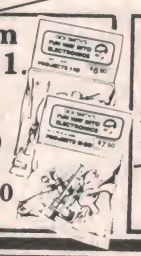

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# LETTERS

**Sir,**

In your March issue, you presented a 'Short Circuit' of a Guitar Sustain, the active component of which was a Motorola MC3340P voltage controlled amplifier.

Having an immediate application for such a unit, I consulted the catalogues of Australia's two largest component retailers, to find neither stocked this vital component. In order to find a supplier, I contacted both Motorola agents. Neither had any stocks, and neither could suggest alternative sources.

Consequently, I contacted your office by phone, and was given the name of two Melbourne stockists, whom you "had been told" carried stocks. Neither did. In desperation, I contacted eleven Sydney component retailers. Not one had current stocks, and only two ever carried stocks; one was just out of stock (around ten weeks' wait) and another was trying to find stocks.

Sir, I find it absolutely incredible that a reputable magazine such as yours could publish a circuit using an essentially unavailable component. Your claim is that 'Short Circuits' are tested, but how could it be tested if the component is unavailable? Surely you have a responsibility to your readers to ensure components for your projects are available — if not, then the circuit should be altered to use a readily available component!

I am confident many other people were annoyed by this lack of planning on your part, and I for one will only continue to read your magazine because limiting my reading to your opposition alone will not allow me to keep up with new developments.

**Edwin Humphries**
**Rockdale NSW**

*Firstly, the unavailability of the MC3340P was not due to "lack of planning" on our part. More likely, it was brought about by the swift action of other readers! However, I must commend your determination and resourcefulness in attempting to find a source of supply.*

*It is our* **standard practice** *whenever a project or Short Circuit is scheduled for a particular issue, to check the availability of components specified. With projects in particular, we often go to a great deal of trouble to ensure that, with components which are not standard stock lines, distributors and/or retailers will have them in stock by the time the issue goes on sale* **and for some time thereafter.** *We retain a freelance correspondent in Melbourne to assist us in this task. Our publishing schedules are such that the contents of a particular issue are finalised about three months ahead. This means that the Guitar Sustain item was readied for production in December and artwork was prepared in January. In mid-January I rang suppliers and distributors to check on availability of components scheduled for projects etc. in the March issue. From memory, some three suppliers indicated they had stocks, so the Guitar Sustain was considered a 'goer'. Now, consider that there is a period of some six to seven weeks from the time the check is made to the time an issue goes on sale. It is* **just not feasible** *to check component availability and alter the contents of an issue if supplies of an item dry up, any closer to the publishing date than that. It seems that what stocks there were of the MC3340P had sold out in the interim or very shortly after the March issue went on sale.*

*As you would appreciate, although we can advise suppliers that particular components will appear in the magazine, we have no control over their stocking policies. You would also appreciate that they are in the component marketplace 'taking a punt' as it were on how many units of each device stocked they will sell to obtain a reasonable return over a period of time. If there is a sudden upsurge in demand and their punt on sales was well below that demand, then clearly their stocks will rapidly run out. The same applies to distributors — in fact, their planning and setting of stock levels is generally much more rigid than that of retailers. For this very reason, we recently introduced a scheme — at the request of several major distributors — to advise distributors* **up to four months in advance** *of semiconductors and 'special' components planned for projects in forthcoming issues. We hope this scheme will go a long way towards alleviating such problems as you found.*

*Returning to your letter, in your fourth paragraph you say you find it "absolutely incredible" we could publish a circuit "using an essentially unavailable component". According to our usual pre-publication check, the component was available! As you can see from the foregoing explanation, we take our responsibility to readers seriously with regard to component availability.*

*Perhaps I can throw the ball back in your court in finishing. Semiconductors are readily and speedily obtainable from overseas if you find them in short supply in Australia, and many resourceful hobbyists use this avenue when necessary (some as a matter of course!). For example, recent issues of English electronics hobbyist magazines (available locally in many newsagents and technical book stores) — Wireless World, for example — carry advertisements which list the MC3340P for sale at 120 pence. Two advertisers I'm looking at as I write this are: Watford Electronics, 33/35 Cardiff Rd, Watford, Herts, UK, and Technomatic Ltd, 17 Burnley Rd, London W10, UK. An international money order or bank draft in pounds sterling for about $3 would secure one by return airmail — accompanied by a flyer or catalogue, like as not!*

*Australia represents a very small market in the electronic component business, despite generally good representation by local firms. For those components which are not consumed in relatively large quantities — unlike 1N914s and 555s, for example — the local stock level is likely to be quite small and supply delays quite long. When there's a 'run' on such components, there'll be disappointed and frustrated customers (or ex-customers!), and there's not a great deal* **we** *can do to prevent it, apart from the advance notification and checking system we already employ.*

*As of 20 March, VSI advised that stocks of the MC3340P were expected in six weeks but they were holding no back orders. Soanar advised that their Melbourne head office had 50 units and that more were expected in around four to five weeks.*

*If you're desperate to build a guitar sustain unit, I would recommend our Project 454, published in the April 1980 issue — which is a combined fuzz and sustain unit to provide sustain alone, fuzz alone or fuzz and sustain. The pc board, semiconductors and suitable other components for this project are normally stocked by Radio Despatch Service in Sydney, while All Electronic Components in Melbourne stock a kit.*

**Roger Harrison**
**Editor**

**Sir,**

Your eminent correspondent "Depresst C-Ber" (ETI, Jan. 1981) has most aptly demonstrated the reason why CB is known as the 'Cretins' Band'. Enough said.

**"V.K."**

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NOTE: This offer does not apply to companies, distributors or re-sellers of Yaesu equipment or their representatives.

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- Superbly easy to operate
- Timer for turning receiver ON/OFF plus control of external equipment (eg. tape recorder).
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*INCLUDES NEW WARC BANDS*

Remember the famous 101 series? Check these features: variable IF bandwidth, RF speech processor. With 180W input (SSB/CW) & AM/CW/SSB. You're ready to take on the crowded bands . . . and win.

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BASE/MOBILE HF

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FV 707

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## POWER IN A SMALL PACKAGE FT 707

240W DC SSB, 80W AM.

What a performer! This small wonder contains all HF & WARC bands. You also get digital display, LED S/power meter, push button operation. It's great for mobile use & makes a superb base station.

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Yaesu call this their 'total performance VHF computerizad transceiver'. You get FM,SSB & CW. over the full 2 metre band. If you want the best, you want the remarkable FT 480R!

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INC. DMS & PS.

P&P EXTRA

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# COMMUNICATIONS

# More VHF TV channels sought

## F.A.C.T.S. seek the facts

The Federation of Australian Television Stations hosted a seminar in mid-March aimed at examining the avenues available to TV broadcasters who are seeking to expand or continue to provide the range of programme choices now enjoyed by the majority of Australians.

**In introducing the seminar, the first in a proposed series, FACTS said, "There has been a lot of discussion during the past couple of years about the future possibilities for television ... some ... proposals will put further pressure on available frequencies whilst others may tend to alleviate the problem.**

"Considered with the adoption of the 1974 McLean Report recommendation to allocate Band II (88-108 MHz) to FM sound broadcasting and an obligation to vacate channel 5A at some future date, the 13 channels determined in 1961 by the Huxley Committee have been effectively reduced to 9 or 10.

"It seems reasonable to assert — and it can be proven — that more than 9 (or 10) VHF channels are needed to continue to provide the programme choices now enjoyed by the majority of Australians and which are more or less promised for everyone.

"In the knowledge that new services would be possible — by satellite distribution, as one factor — and that the General World Administrative Radio Conference (WARC '79) held in Geneva in late 1979 would provide an opportunity for Australia to put its frequency allocations house in order, FACTS began pressing the Government for action in June 1978.

"The consistent request, repeated many times since then, has been for an enquiry to determine the future needs of the Australian public for broadcasting services — not just to allocate frequencies for a defined number of services, but to look at social, economic, political, demographic and technical aspects of the question.

"Nothing has happened."

That provides some background to the efforts of FACTS to catalyse some discussion on the question. Basically, what is sought is a 12-channel system in VHF Bands I and III. A variety of proposals were put and discussed at the seminar. Proposal 'a' for Band I involved moving channel 0 down by 1 MHz (putting the 6m amateur band between 51 and 53 MHz) and channels 1 and 2 down by 3 MHz, plus adding a channel above channel 2, between 67 MHz and 74 MHz. Apparently, many tuners will not cope with this. Proposal 'b' for Band I left channel 0 in place, added a channel between 52 MHz and 59 MHz (eliminating the amateur 6m band — oh, horror!) and moving channels 1 and 2 up 3 MHz. Same problem as Proposal 'a'. Proposal 'c' left Band I alone but required the retention of 5A. Jim Wilkinson of the Australian Broadcasting Tribunal put the kibosh on that by announcing that the Prime Minister had decreed that 5A was to go. Full stop. No time scale was proposed, though. Proposal 'd' left 5A out, but added channel 3, to be allocated on a regional basis, so as not to interfere with FM broadcasting.

In Band III, the proposal put it that two extra channels could be gained (channels 12 and 13). Firstly, if the present fixed and mobile and DME stations between 202 MHz and 208 MHz were removed, channel 13 could be placed here if channels 10 and 11 were moved up 1 MHz. Secondly, by clearing 223 MHz to 230 MHz of the current DME and government services, channel 12 could be placed in this region. Most current and past TV front ends could cope with this, it seems.

A number of hitherto unpublicised problems with both VHF and UHF broadcasting came out at the seminar. Firstly, Band I (channels 0, 1, 2) stations have many problems. Channel 0 especially has propagation, reception (antenna) and interference problems. All Band I stations will have difficulty with Teletext transmissions owing to propagation distortion causing errors which are unacceptable. Indeed, the ABC (channel 2) is running trials with the French Antiope system in an effort to overcome the problem.

To provide appropriate signal levels and coverage similar to that of VHF stations, UHF stations have to run around three times the e.r.p., it seems. Also, capital cost of a UHF station is around four times that of a VHF station, as is the running cost.

**Roger Harrison**

### * Stop Press! *

Announcing the start of ABC trials of the French Antiope data broadcasting system on April 6, the Minister for Communications, Mr Sinclair, said it would enable comparison with the UK Teletext system.

"It is important to try as many systems as possible before deciding on the most suitable system for Australia," the Minister said.

"Factors which must be taken into consideration include the reliability of the system, its cost to the consumer and operator, and its suitability for providing captioning for the hearing impaired."

**He re-affirmed Mr Tony Staley's February 1980 statement that the system would be reviewed at the end of three years.**

"Anyone purchasing decoding devices suitable to one of the systems being tested over that period should realise that there is no guarantee at this stage that their decoder will suit the system finally agreed on."

## Fortnightly propagation predictions

**George Jacobs, well-known US radio amateur and propagation expert, offers a propagation prediction service.**

Available on subscription for US$25, the publication, Mail-a-Prop, is published and distributed every two weeks. Enquiries should be directed to George Jacobs, Mail-a-Prop, Box 1714, Silver Spring, Maryland USA MD20902.

George also has his new book for sale, Shortwave Propagation Handbook, for US$7.95. Enquiries to address above. We've not seen it stocked locally.

Don't forget that the NSW Division of the Wireless Institute of Australia includes a weekly propagation report and forecast in its Sunday morning broadcasts at 11 am EAST on the 3.5 MHz, 7 MHz 28 MHz, 52 MHz, and 144 MHz bands and via relay stations on other bands.

## 500 MHz quartz crystals!

**A technique for producing quartz crystals so thin that they vibrate at a fundamental frequency of 525 MHz has been put into pilot production by the Compagnie d'Electronique et de Piézo-Electricité (CEPE).**

A Thomson-CSF subsidiary, based in Sartrouville, near Versailles, the firm starts with quartz slices lapped to a thickness of some 33 $\mu$m, equivalent to a 50 MHz fundamental, and then thins them down by ion bombardment to about 3.2 $\mu$m and a 525 MHz fundamental — the highest yet, says CEPE.

Though chips as thin as this are still experimental, the French firm expects to produce industrial versions with fundamental frequencies of 400 MHz.

# MR BUSINESSMAN!

## here at last from DICK SMITH is a

# STOCK CONTROL & PRICING SYSTEM

## especially designed for Australian conditions


No, not just another software package imported from overseas, but one that has been written (at great expense)

***by Australians for Australian businesses***

In fact it has been modelled closely on the Stock Control and Pricing System used so successfully by Dick Smith Electronics.

The original system runs on an IBM computer costing more than $50,000 — but you can have the same benefits for less than one tenth of this cost (yes, for both the computer hardware and the software!)

While you're in one of our stores why not check out the many features of the System 80 and its peripherals?

You, and your business can benefit from this amazing system for less than you think!

## HERE ARE JUST SOME OF ITS OUTSTANDING FEATURES

Cat X-3750

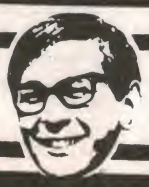
- Capacity for up to 1200 stock lines!
- Machine-language sorting for FAST operation!
- Ability to print out price lists as well as stock status reports and other listings (all dated!)
- Fast stock and financial status reports on the screen!
- Simple "menu-driven" operation — no special training required!
- Prints out stock count sheets for stocktaking, then gives you a printed analysis of all discrepencies!
- Special Australian Sales Tax feature (optional)!
- Easily expandable — so you're not forced to change to another system as your business expands!

**$275!**

(Program & Data Disks with comprehensive User Manual)

**The full Dick Smith business computer system includes computer, monitor, disk-drives, expansion interface, large memory, cables, etc. — costs just $3,480.00. So with SCAP you can have a superb operating system for well under $4,000!!!**

**DICK SMITH Electronics**



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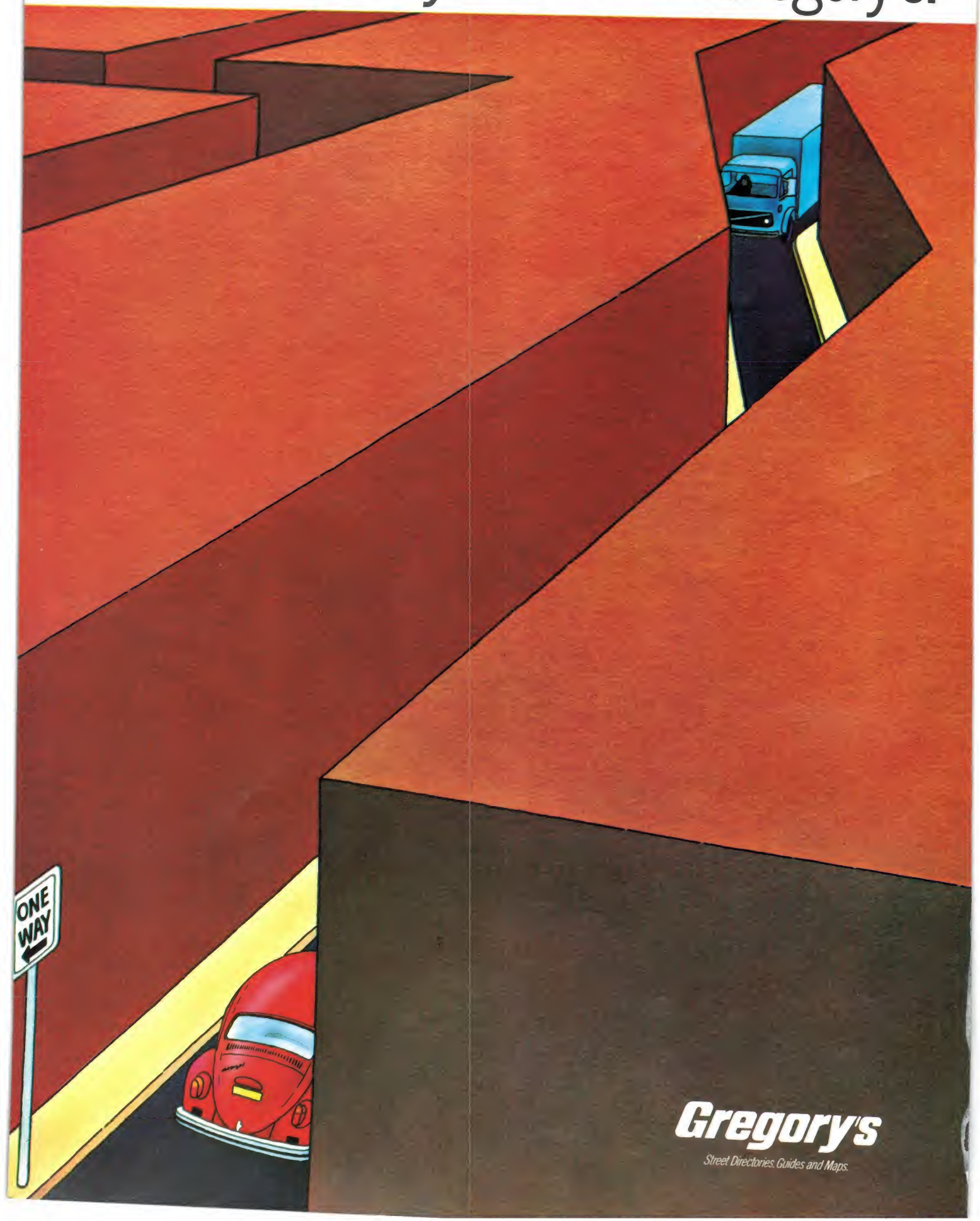



**Gregory's**

*Street Directories, Guides and Maps.*

# COMPUTING TODAY

## Say it again, RAM!

The DT1000, a fully assembled circuit board containing all the components necessary to output speech upon demand, is now available from National Semiconductors.

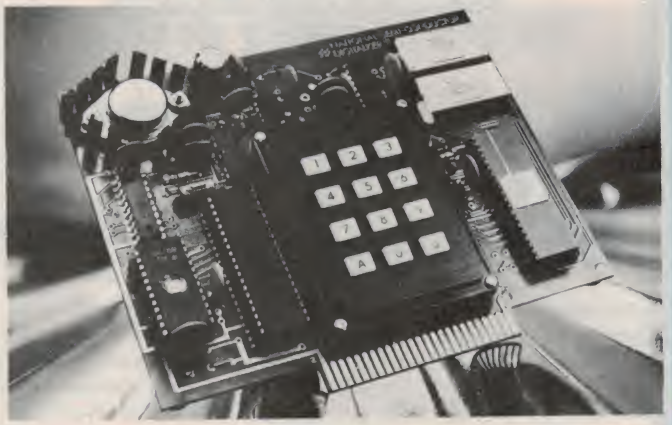
**The DT1000 evaluates the operation and application of the Digitalker speech synthesis chip, in either an end or stand-alone product, and requires only a 9 V power supply and an inexpensive speaker for operation.**

It contains National's speech processor chip, two speech ROMs containing 138 individual words, output filter, audio amplifier, keyboard and a COPS microcontroller and EPROM that contain stored data programmed to provide the various functions of the board.

The two speech ROMs enable the user to link words consisting of numbers and letters of the alphabet, assorted useful nouns, verbs, tones and silence durations into phrases and sentences. The speech quality reproduced is claimed to be very realistic, even sounding much like the original person's voice.

The Digitalker is claimed to have the unique function of reproducing inflection and intonation of the original speech, not just the words spoken; the speaker is even said to be clearly recognisable. This feature is regarded as important in applications where the general public is listening to speech produced by the system — in telecommunications, instruments, control systems, appliances, and even in toys and games and car dashboards!

Contact National Semiconductor Australia Pty Ltd, cnr. Stud Rd and Mountain Highway, Bayswater Vic. 3153, (03)729-6333, for more information.



## Z80 and Pascal-100 marry on S100 buss

**The Pascal-100, a new two-board central processing unit, combines a Z80-type microprocessor and Western Digital's Pascal Microengine to yield five to ten times faster execution times than a Pascal-programmed Z80 alone.**

The CPU is compatible with the S100 computer buss and, according to its developers, Digicomp Research Inc, Ithaca, New York, may be the first 16-bit microengine to be combined with another microprocessor — in this case an 8-bit unit.

A key advantage of the dual-processor system is compatibility with existing applications software written for 8-bit Z80- or 8080-based systems or those using the CP/M operating system, as well as with new software like UCSD Pascal. which accesses the 16-bit processor's larger address space.

The Pascal-100 costs US$1485.

## Low cost Commodore

**Trying to bridge the gap between the hobbyist and small-business computers, Commodore Business Machines introduced a US$300 colour graphics computer at the January US Consumer Electronics Show.**

Called the VIC 20, it contains a video interface chip that allows it to display material on an ordinary TV set through an external RF modulator.

However, the display is limited to 23 lines of 22 characters each.

The VIC 20 uses Pet BASIC.

## Crusading Computercamp

**May 9-16 1981 has been scheduled for the third Computercamp, where high school students from Years 10-12 can learn to program computers and computer applications.**

Computers of the table-top variety have been made available by various computer houses and educational institutions, and in the past some students have even brought along their own machines.

Newcomers to computing are taught how to program in BASIC in a series of graded exercises. After only one week's camp some students have been able to produce quite sophisticated programs, such as motor trajectories, dodging of random land mines, Hammurabi, and many others.

The camp, run by the Crusader Union of NSW, has a Christian emphasis and seeks to present the Christian message in an environment which is up to date with the latest technology and will also allow students to pursue an interesting and challenging activity.

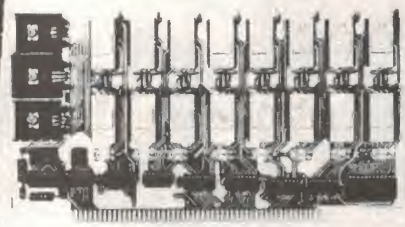
Set in a bushland site at Galston, the camp also provides for such activities as outdoor games, hikes and barbecues. Numbers will be limited to 40 (possibly 20 boys and 20 girls), and 13 of last year's campers have already reapplied. The camp caters for all grades from beginner to expert.

Enquiries should be directed to Mr A. Potter, (02)95-6926.

# ROD IRVING ELECTRONICS

## 425 HIGH ST., NORTHCOTE

### S100 COMPUTER PRODUCTS
### 16K EPROM CARD-S 100 BUSS



**$89.50**
**KIT**

**FIRST TIME OFFERED!**
**BLANK PC BOARD - $39**

**USES 2708's!**

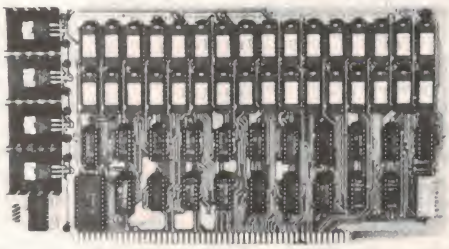
Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at **ALL TIMES!** Kit features a top quality soldermasked and silk-screened PC board and first run parts and sockets. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

OUR 450 NS 2708'S ARE $8.95 EA. WITH PURCHASE OF KIT

ASSEMBLED AND FULLY TESTED ADD $36

### 16K STATIC RAM KIT-S 100 BUSS

**KIT $249**
**A&T $279**



KIT FEATURES
1. Addressable as four separate 4K Blocks
2. ON BOARD BANK SELECT circuitry (Cromemco Standard!) Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers
6. All address and data lines fully buffered
7. Kit includes ALL parts and sockets
8. PHANTOM is jumpered to PIN 67
9. LOW POWER: under 1.5 amps TYPICAL from the +8 Volt Buss
10. Blank PC Board can be populated as any multiple of 4K.

BLANK PC BOARD W/DATA **$49**
LOW PROFILE SOCKET SET **$19**
SUPPORT IC'S & CAPS **$27**
ASSEMBLED & TESTED-**ADD $30**

**OUR #1 SELLING RAM BOARD!**

**ITOH Model 8300 PRINTER. $810 plus 15 percent sales tax.**
This 80-column printer provides quiet operation, making it suitable for use in offices, classrooms and homes. Specifications include 125 cps, 60 lines per minute, paper loading from bottom or rear and Centronics-compatible parallel interface.
A bi-directional, dot matrix impact printer with a print head designed for 100 percent duty operation, assuring a print life that exceeds 100 million characters. The precision sprocket-feed mechanism permits printing forms from 4½ to 9½ inches wide. A 96 ASCII character set prints in upper and lower case with the added capability of producing double-width fonts in bold face. The vertical format unit provides preprogrammed/programmable tab positions, top of form and bottom of form for complete formatting capabilities.

**ETI636 7-SLOT MOTHERBOARD WITH ACTIVE TERMINATION**
Kit of Parts $79.00. Assembled and tested $105.99 (inc. tax), RITRON COMPUTER GRADE POWER SUPPLY: 5V Reg, 10A, 16V Unreg. Kit of parts $79.95 inc. tax. A&T $99.95 inc. tax. Write for list of other power supplies. Tax free prices also available.

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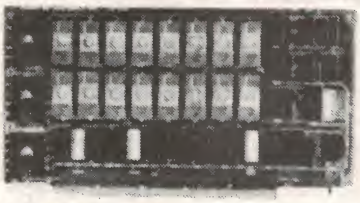
## Australia's first under $300 COMPUTER..

# sinclair ZX80


***FEATURES:***
Includes leads etc Basic on board in PROM unique basic interpreter affords single key functions up to 26 string handling powerful editor high resolution graphics. All documentation included single ROM contains basic interpreter cha gen, operating system and monitor less RAM required due to large PROM expandable to 16K small compact size connect your TV direct and cassette recorder and you're away.

### 32K S-100 EPROM CARD *NEW!*



**$99.95**

**KIT USES 2716**
**Blank PC Boards — $45**
**ASSEMBLED & TESTED ADD $30**

KIT FEATURES:
1. Uses +5V only 2716 (2Kx8) EPROM's
2. Allows up to 32K of software on line.
3. IEEE S-100 Compatible.
4. Addressable as two independent 16K blocks.
5. Cromemco extended or Northstar bank select.
6. On board wait state circuitry if needed.
7. Any or all EPROM locations can be disabled.
8. Double sided PC board solder masked silk-screened.
9. Gold plated contact fingers.
10. Unselected EPROM's automatically powered down for low power.
11. Fully buffered and bypassed.
12. Easy and quick to asssemble.

**SPECIAL: 2716 EPROM's (450 NS) are $11 ea. with above kit.**

### 16K STATIC RAM SS-50 BUS

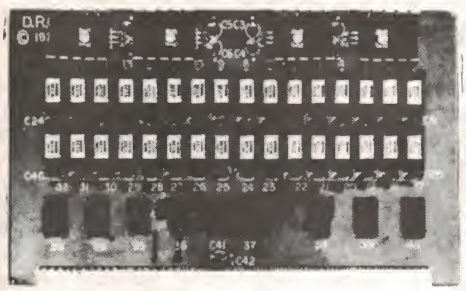
***PRICE CUT!***

**$229**

**FULLY STATIC AT DYNAMIC PRICES**

**FOR SWTPC 6800 BUS!**

**ASSEMBLED AND TESTED — $30**



KIT FEATURES
1. Addressable or 16K boundaries
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3. Runs at full speed
4. Double sided PC Board, solder mask and silk-screened layout. Gold fingers
5. All parts and sockets included.
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16K Dynamic RAM, Board assembled and tested: Special $269 plus tax (2mHz), $299 plus tax (4mHz). This must be the best offer available on quality tested dynamic RAM Boards.

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*ETI5/81*

**General enquiries (03) 489-8131. Mail order enquiries (03) 481-1436. Ritronics Wholesale (03) 489-7099.**

**Prices current till June 7, 1981. Heavier items add additional postage. Extra heavy items sent Comet freight on. Prices subject to change without notice. Send 60c and SAE for free catalogues. MAIL ORDERS PO Box 135, Northcote, Vic 3070. Minimum pack and post $1.**

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- No stripping or slitting required—just wrap
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| R-JW-B | Blue | 50 ft roll | $4.99 |
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| R-JW-Y | Yellow | 50 ft roll | 4.99 |
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Spectrol model 534 ¼" shaft.
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### EPROM PROGRAMMER KIT

Kit of parts as featured in Electronics Australia July, 1980. Programs 2708, 2716 and 2532. Use with TRS80, Sorcerer, and Compucolor. Kit does not include connector from the programmer to computer.

| | |
|---|---|
| Complete Kit | $72.49 |
| Kit without case | $59.99 |
| Pack and post | $2.50 |

### DIG CAPACITANCE METER

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| Complete Kit | $52.49 |
| Kit without case | $39.99 |
| Pack and post | $2.50 |

## COMPONENTS

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| 555's 10 up | 2.90 |
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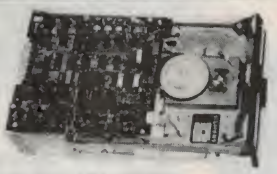
- P.C.B.'s (all quality fibreglass boards)
  ETI 574 disco strobe 2.80
  ETI 549A metal detector 2.75
  DREAM circuit board 10.90



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5in Minifloppy Drive
$399.00 Tax Inc
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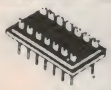
**16 4116s for $40.00**

**STATIC RAM KIT 16K S-100**
**2114 $2.90; 2716 $11.00; 2708 $6.90**

### DIP PLUGS



Ideal for use with flat ribbon cable or to mount components on
14 pin $1.20
16 pin $1.40
24 pin $1.20

### POWER TRANSFORMERS

SPECIALLY DESIGNED FOR MICROCOMPUTERS

- Good regulation electrostatic shield
- RI 810 8V@10A 2 x 15V@1A $24.50
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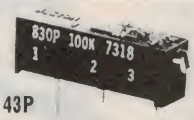
### 20 TURN CERMET TRIM POT




SPECTROL 43P ACTUAL SIZE

STOCK RESISTANCE VALUES
10R, 20R, 50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1M, 2M.

| | |
|---|---|
| 1—9 | $1.40 |
| 10—99 | $1.30 |
| 100 | $1.20 |

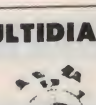
Values may be mixed.

### Hexadecimal Keypad $24.50/each

19-key pad includes 1-10 keys ABCDEF and 2 optional keys and a shift key.

Ideal for dream project

### MULTIDIALS




Dials to suit 10 T Pots

| | |
|---|---|
| Model 21 1.8" dia | $16.50 |
| Model 16 .9" dia | $12.50 |
| Model 18 1" x 1.75" dia | $20.60 |

### COMPUTER COOLING FANS

Muffin fan 4⅝" square

| | |
|---|---|
| 110V | $39.50 |
| 240V | $26.50 |

Range of larger fans available. Send for details

### cermet single TURN TRIM POT

Spectrol model 63P ACTUAL SIZE

STOCK VALUES
10R, 20R, 50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 200K, 500K, 1M, 2M.

| | |
|---|---|
| 1—9 | $1.00 |
| 10—99 | 0.90 |
| 100 | 0.80 |

Values may be mixed.

### P.C. EDGE CONNECTORS

| | |
|---|---|
| S100 gold plated wire wrap | $8.50 |
| S100 solder tail | $6.90 |
| D2 Motorola bus 43/86 solder tail | $8.50 |
| 43/86 gold plated wire wrap | $10.50 |

## HAVE YOU BUILT A DREAM YET!

**ELECTRONIC AUSTRALIA MICROCOMPUTER PROJECT**

| | |
|---|---|
| Kit for main board (including programme 2708) | $109.00 |
| Also available re-designed 6802 PCB | $11.90 |
| PCB (Fibre glass) only | $10.90 |
| 2708 programmed | $15.50 |
| Key Pad 19 Keys | $24.50 |
| Kit (less key pad) | $94.00 |
| PCB for power supply | $3.50 |

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# Print-out

# In 1981, it's the ZX81 !

Sinclair Research has done it again — only this time around, a little more refined. In April, their newest 'personal' computer hit the market — the amazing ZX81.

**This new machine is a much-upgraded version of the ZX80, incorporating an 8K BASIC ROM, higher speed Z80A processor and using a mere four chips compared to the ZX80's 21!**

The ZX81 retains the one-touch key word entry feature of the ZX80 plus the graph-drawing and display facilities. The ZX81 will do animated graphics, though, according to the information from Sinclair Research. It also includes a 'randomise' function (as per the ZX80) which is said to be useful for games amongst other things. With the ZX81 you can LOAD and SAVE named programs on cassette.

The ZX81 is priced at around STG£70, which probably translates to $200 here.

But there's more! Sinclair has announced they will have their long-awaited ZX Printer available sometime around mid-year for a price around STG£50. The ZX81 can drive it directly, while you'll need the 8K drop-in BASIC ROM in your ZX80 to drive the ZX printer.

We await the arrival of these goodies with a great deal of interest.


**The Sinclair ZX Printer, designed for use with the ZX81, offers full alpha-numerics across 32 columns and highly sophisticated graphics. A COPY command prints out exactly what's on the TV screen.**

## APF 1M-1 for Australia

**The Radio Parts Group of Melbourne and Calculator Discounts, also of Melbourne, are the joint Australian importers of this little four-colour wonder that comes from Hong Kong.**

The APF 1M-1 has already taken on very well in the American market, and for the price of $995.00 (including sales tax) should do very well in Australia; it is certainly some of the best value for money seen to date.

For your $995.00 you get:

**MP 1000 microprocessor programmable TV game.** Plays on black and white or colour TV. Has two remote hand-held controls with keyboards and joysticks for various types of games.

**MPA10 computer module companion.** Converts MP-1000 to full user programmable personal computer. Full typewriter keyboard, cassette deck. We hear that those clever Chinese have solved all the loading problems sometimes associated with the low end of the computer market.

**TV Monitor.** A 13-inch colour unit that gives excellent colour resolution for graphics and games.

Probably the best feature of this new computer is that it can be added to with a number of peripherals. Peripherals available to date include:

BB-1 expansion unit with printer interface.
80-column printer (approx. $575).
BB-s expansion unit with mini-floppy interface.
R-8K RAM memory expansion.
D100 disk drives.

All these peripherals are of moderate price, and a complete system is available for use at schools and in business for $3049.

Watch ETI for coming review — we're looking forward to getting our hands on this one.

# 64K CMOS static RAM a first from Toshiba

**Toshiba may be the first chip maker to introduce a complementary MOS 64K static random-access memory.**

Now in development is an 8K-by-8-bit 28-pin device with cells that measure 15 by 19 micrometres on a 4.6 by 6.55 mm (46 700 sq. mil.) die.

Power dissipation is 50 mW active and just 100 microwatts on standby. Wafer steppers and 2-micrometre features have been used for the first pass on the RAM, which has no redundant elements.

The 64K static RAM is over a year away, but this year the Japanese company will supply samples of the 8049 single-chip microcomputer, also in CMOS. With 3-micrometre rules, that chip will measure 22.8 $mm^2$ (35 350 sq. mil.) and draw 50 mW for active operation and only 50 to 500 microwatts while idling.

Later this year, Toshiba will also be in production with a 64K erasable programmable read-only memory — in n-MOS — with a pin-out that matches Intel's.


# New store for AED

**AED Microcomputer Products recently announced the opening of their new store at 130 Military Road, Guildford NSW 2161.**

This new store is only seven doors away from their old establishment, but they say it is eight times larger and boasts a large, airy showroom, administration offices, workshops, development laboratories, design offices and a seminar room.

AED handle what they believe to be the largest range of S100, CP/M and related products in Australia. Complete computers range from the Sorcerer to 'Rolls Royce' 4 MHz S100 machines. Epson Base 2 and Iton dot matrix printers are available, together with TEK and the NEC Spinwriter daisy wheel units.

AED are S100 and CP/M specialists, from complete computers through add-on disks, S100 cards, etc, to prototype equipment and parts. Available software covers all areas of microcomputing, including word processing and business applications.

A full range of magazines is always available, and special parts or software, not normally available in Australia, can be imported to the customer's order.

For further information contact Acoustic Electronic Developments Pty Ltd on (02)632-6301 or (02)632-4966.

# New floppy disk system

**AED Microcomputer Products of Guildford, NSW, have just released a new floppy disk system for S100 computers.**

Priced about midway between the usual single and double-sided systems, AEDisk is a double-sided, double density 8" system using YE data drives. These are housed in a polished timber and vinyl-coated steel case that matches the "VN-Serial" terminal.

The controller used is the latest version of the tried and proven Morrow (MR IEEE S100) disk jockey 20. Drives and controllers are available separately, although the complete package includes CP/M 2.2, and a special version is also available at no extra charge.

Capacity per disk is a maximum of 1.2M (DS, DD), but the system will still handle single-sided, single density disks, for example for software installation, etc. Both single and dual drive systems are in fact available; in the latter case the drives may be supplied in separate cases or in a single case, either side by side or stacked.

Up to four floppy drives can be accommodated on the one controller, and the system integrates perfectly with the Morrow 10M and 26M hard drive systems.

For information on these and other S100, CP/M and related products, contact Acoustic Electronic Developments Pty Ltd, 130 Military Road, Guildford NSW 2161. Phone (02) 632-6301, (02) 632-4966.

# Bubble cassettes

**Although at present more costly than other magnetic media, bubble memory technology offers microprocessor-based systems a unique combination of non-volatility, long-term reliability, and data integrity, even in harsh environments. Now National Semiconductor is adding several other dimensions to the technology with the development of a magnetic bubble memory cassette system.**

Designated Bublset, the new system consists of a read-write unit, less than 3 by 4 by 6 in. in size, that automatically accepts magnetic bubble cassettes ranging from about 100K to 1M in capacity.

According to Frank Stempski, product marketing manager for magnetic bubble products, the system was developed in response to the need for a removable, non-volatile solid-state memory in such applications as numerical machine-tool control, data loggers and recorders, portable terminals and intelligent test equipment, and military systems in harsh or dirty environments.

Bubble-based storage systems have no moving parts and thus are not subject to the mechanical failures of tape and disk storage.

The Bublset's temperature range of −20° to +70°C extends well below that of most competitive media, which are limited to 0°C, Stempski states. The lower range is needed on oil-well data-logging systems and on power-demand meters located outside buildings, as well as in many shipboard and airborne applications, such as flight-management recording systems.

The Bublset cassette has no function or coil drivers and no sense amplifiers — it contains only the bubble memory and temperature-sensing circuitry. "The design avoids the data loss typically due to powering up or down or from removing a magnetic tape cassette during operation," says George Reyling Jr., manager for magnetic bubble memory systems.

The bubble memory controller detects and corrects errors automatically. It has built-in self-test features as well as an automatic write-protection feature.

The system comes with two selectable ports — an RS-232-C serial interface and a byte-wide parallel port for interfacing with microprocessor-based systems. Its +5 V and +12 V power supply requirements and the low power consumption typical of bubble memory technology increase its suitability for portable applications, Stempski notes.

National will make the Bublset available in the general marketplace in the second half of this year. For industrial-grade versions, the Bublset will be priced in the US$1000 range in small quantities. The price includes the read/write system and a minimum-capacity (100K) bubble memory cassette. Prices of the cassettes will vary with capacity. Militarised and more rugged versions will be available next year.

# The one-stop Microcomputer Shop for total service to TRS-80* users

*TRS-80 is a registered Trademark of Tandy Radio-Shack

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Executes up to 60 times faster than DISK BASIC.
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Includes the fastest and most powerful screen editor we have seen.
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BASIC EXTENSIONS by G.J. Howe.
Absolutely essential for every BASIC Programmer, novice to professional. Single steps through every BASIC statement. Full HEX-ASCII memory dump. Enable/disable BREAK key. 2-kit SCREEN-PRINT command dumps video to printer. ..... $9.95

MCMOM by M.J. Dinn of 80-Software.
MCMOM provides all the facilities needed to write, run, debug and save machine level programs. Single step through ROM, RAM indefinitely or until a pre-set break-point is reached. Displays all register contents at every step. Immediate switching to Z80 mnemonics display, if required. Many other features.
Level II 16-48K ..... $19.95
Disk version available soon.
Exclusive to CISA and authorised agents.

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Now accepts most types of cassette player. Essential for use with HISPED. No internal modifications $57.50

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Both keyboard and i/face.
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Operate any RS232 or 20MA serial printer with this Australian made unit. Includes software ..... $54.75

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Five brilliant games in the classic space series ..... $14.50

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Yes, we are now in a position to undertake any repair of any nature (except plastic cases) to any Tandy Model I or Model II equipment or any of our own peripherals. No fancy surcharges if you have any previously fitted mods.

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HIRES BOARD ..... $225.00
Fitting ..... $25.00
System 80 version ..... $275.00
(As it is an extremely complex task to fit this to the System 80, no boards will be sold separately.)
Lower case is not fully implemented in the System 80 as the essential ingredients are just not there.

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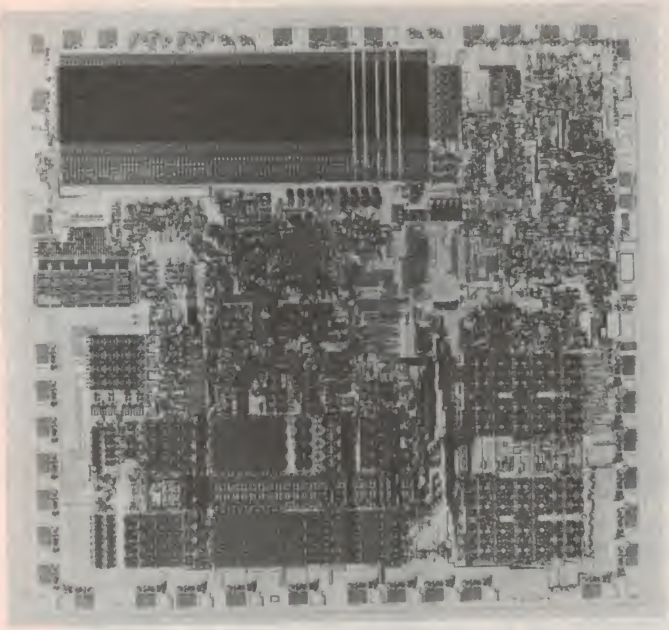
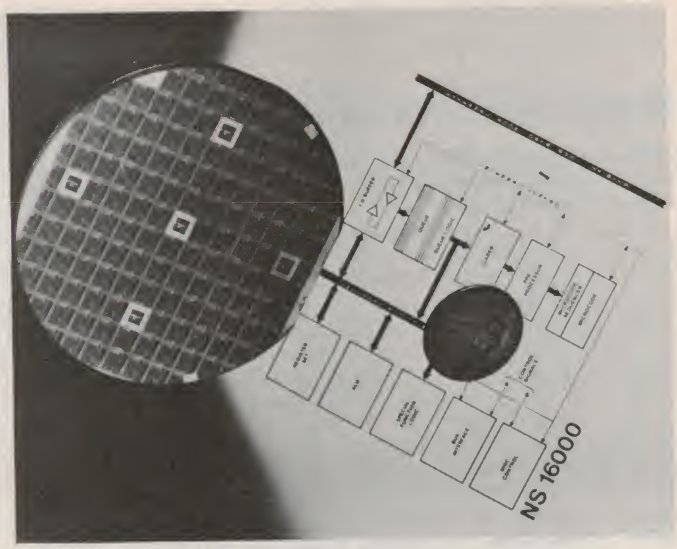
# Print-out






## National Semiconductors unveils 16-bit micro

**The first wafers of the NS16032 microprocessor were produced in December last year at National's Utah factory, and evaluation and debugging of the complex 16-bit micro are now being carried out.**

According to National, the 16000 family offers virtual memory, high level language support, symmetric register set, memory-to-memory operations, powerful addressing modes, numerous data types, symmetric instruction set, memory management and large, uniform addressing, plus unique modular software support and a slave processing facility.

The family supports a wide variety of system configurations, extending from a minimum low-cost system to a powerful 16M system. It will be fully supported by a complete family of development systems, compilers, operating systems and board level products.

National also announced an agreement with Fairchild Camera and Instrument Corporation to second source the NS16000 family. Under the agreement there will be an exchange of mask-making data for the NS16032 CPU and systems-oriented devices with data on Fairchild's dedicated peripheral circuits.

## Here's lead in your pencil!

**An 'electronic blackboard' that will allow users to write directly on special pressure-sensitive screens has been developed by Sanyo Electric Inc., a US division of the Japanese company.**

The blackboard employs a light pen and a screen. When the light pen touches the screen, a signal is sent to an internal microprocessor which generates a video display. Thus you draw on the screen in the same manner as you would draw on a blackboard.

A display at the bottom of the screen permits the user to select from 16 colours by touching the pen to the appropriate colour and then drawing on the screen.

The completed drawing can be transferred to a floppy disk for storage and future use. A printer can be attached to provide hard copy.

## VDU to take Australia by storm?

**The TVI-950, manufactured by Televideo and released in Australia by Anderson Digital Equipment, is confidently expected by them to take the Australian market by storm, as it is said to have done in the USA.**

The detachable keyboard has 11 special function keys (22 functions with the shift key) that can be programmed to the user's requirements using 256 bytes of on-board RAM. In addition keys, key functions and even keyboard locations can be changed, and other features include advanced editing with wraparound, split screen with line lock, smooth scrolling, and a 25th status line. Fifteen special characters for powerful line graphics are available as a standard.

The TVI-950 will sell at $1595 plus tax for one-off, with quantity discounts available on request. Contact Anderson Digital Equipment Pty Ltd, P.O. Box 322, Mount Waverley Vic. 3149, (03)543-2077, for more information.

## Powerful desktop computer system

**The DSD 880 Winchester/floppy disk storage system can be used to configure a compact and powerful desktop computer system in partnership with the DEC VT-103 intelligent terminal, according to its suppliers, Anderson Digital Equipment.**

The DSD 880 is said to be fully compatible with DEC hardware, software and media, and can be used with any system based on the popular DEC LSI-11 processor.

Ideal for any application where space is at a premium, the DSD 880 combines an eight-inch Winchester and an eight-inch floppy in a compact 5¼" high package.

The Winchester provides 7.8M of formatted capacity; the floppy gives an additional 1M and accepts all combinations of single-sided/double-sided and DEC single density/double density diskettes. In most applications the Winchester is the primary on-line storage due to its higher capacity and performance, and low-noise operation. Users may obtain software and diagnostics directly from DEC on floppy disks.

DSD 880 users can move readily from one DEC operating system to another, and can expect to remain compatible with future releases of DEC software. Developers of systems incorporating the DSD 880 can use DEC diagnostics for debugging.

The DSD 880 costs $7450 in single quantities, and further information may be obtained from Anderson Digital Equipment Pty Ltd, P.O. Box 322, Mt Waverley Vic. 3149. (03)543-2077.

# Printout

## Super Text 2 for all those little Apples

**Muse Software of Baltimore, USA, have announced the release of a new word processor, called Super Text 2, which is compatible with all species of Apple.**

Super Text 2 displays either with the normal character set or with the set provided by the 'Dan Paymar Lower Case Adaptor', and according to Muse will enable anyone "to be writing, saving to disk and printing professional-quality copy within minutes of opening the manual". Later sections of the manual are said to teach the user to do tricks and variations on standard letters and files, and the system also has the capability of completing direct mathematical calculations, calculations on numbers in a file, column totals, etc, as well as normal word processor functions. Slave disks may also be copied, even if sectors of them have been damaged.

Muse will be providing add-on facilities to enable Super Text 2 users to have the Form Letter Module, Terminal Module, and the Virtual Memory Assembler.

Unlike most other word processors, the Super Text 2 uses the shift key to call upper case in the way a normal typewriter would; there is no need to use the 'escape' key to obtain upper case displays and printouts.

Seahorse Computers are offering the Super Text 2 for $149, and if you wish to trade in your old word processor, they will give $90 credit on a Super Text and $50 on an Apple Writer, Easy Writer, or Apple Pie.

More details of the Super Text 2 are available from Seahorse Computers, P.O. Box 47, Camden NSW 2570, (046)66-6406, from whom Super Text and the Dan Paymar Lower Case Adaptor are also available ex-stock.

## A rolling bubble gathers no MOS

**Bubble memory shipments will increase 65% a year, from US$18.4 million in 1980 to US$100 million in 1983 and US$226 million in 1985, according to Venture Development Corporation in the US.**

First major applications have been in areas such as numerical control of machine tools, where dust and chemicals in the atmosphere make moving magnetic media unsuitable, and in portable terminals where resistance to shock is important.

Small computers and word processors will be increasingly important applications.

As prices of bubble memories decrease with larger volumes and more experience in producing them, the use of bubbles will shift from specialised areas such as adverse environments to more general memory applications.

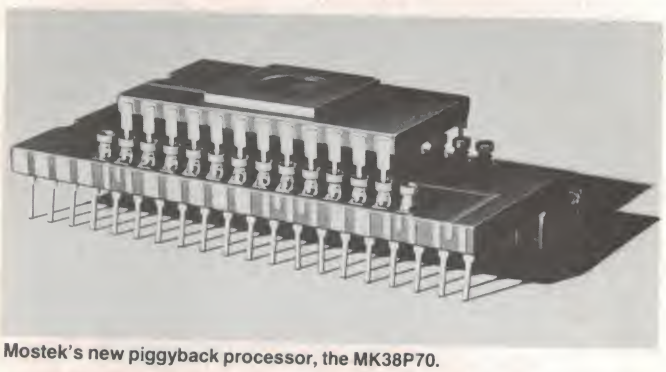
New bubble units pose a threat to fixed head disk drives but not to floppy disk systems. Fixed head disk drives will be displaced by bubbles when the price drops to 15 cents/Kbit in 1984, says the Corporation.

Meanwhile, Rockwell has dropped out of the bubble memory market. It is believed that Motorola's decision not to second-source Rockwell's 256K-bit bubble memory and instead produce its own 1M device was a serious setback to Rockwell.

The price erosion in semiconductor memory devices, particularly in 64K RAMs, slowed the development of the bubble memory market, according to Robert Anslow, EDD world-wide sales director for Rockwell.

## New address for Sorcerers

**The Sorcerer Users' Group in Victoria, which has been established for over two years and has a current membership of over 400, now has a new postal address. Contact them via The Secretary, Sorcerer Computer Users of Australia (SCUA), P.O. Box 144, Doncaster Vic. 3108.**



Mostek's new piggyback processor, the MK38P70.

## RAMs, chips and cables

**Amtron Tyree recently released three new products designed to expand their computing range.**

• The Mostek 'Bytewide' RAM was designed to be completely compatible with the most popular industry-standard ROMs and EPROMs, so that memory boards may be configured to accept any mixture of RAM, EPROM and/or ROM. By using PROM or EPROM devices to decode addresses and two wire jumpers per memory chip, a designer can now design a universal memory board upon which both page boundaries and memory type (RAM, ROM or EPROM) may be varied at will, according to Amtron Tyree. Mostek is also committed to compatibility between today's memories and future generation devices.

• The new Mostek MK38P70 can 'piggyback' any one of five popular EPROMs, producing a highly versatile single-chip microprocessor said to be very suitable for low-volume Australian market conditions. The MK38P70 family features include: 1K, 2K or 4K of EPROM, programmable timer, external interrupts and single 5 V supply.

• The 57F series is a flat cable version of the well-known Ampenol 57 series micro ribbon connector. It is currently available in 36 and 50-way versions, with 14 and 24 to be coming soon. Features include positive spring, latches, 20 000 insertions and withdrawals, and simple and reliable termination to 0.05" flat cable. These connectors are interchangeable and intermateable with the 57 series solder or micro-pierce insulations displacement connectors for intercabinet or flat-to-round cable transitions.

Further information on all these products can be obtained from Amtron Tyree Pty Ltd, 176 Botany St, Waterloo NSW. (02)698-9666.

## Zilog cuts price of Z8000

**With the introduction of the Z8002 and Z8001 MPUs in plastic packages instead of ceramic DIP, Zilog has cut prices drastically.**

The Z8002 will now be priced at US$19.90 in quantities of 1000; formerly it was US$45. The Z8001 MPU and the memory management unit (Z8010) is being offered as a kit in plastic packages at US$49.50 each at the 1000-piece level, compared with a former price of US$139. The ceramic prices for the Z8001 and Z8002 have not changed.

Zilog is aiming the Z8002, a non-segmented MPU which addresses 64K bytes of memory, at applications such as printer controllers. The Z8001, a segmented MPU addressing eight bytes of memory, is aimed at medium- to high-end performance applications.

When contacted for comment on Zilog's price reduction, the general manager for Intel's microprocessor operation said, "It is a belated move on their part to make the processors competitive with the 8086 and 8088." He disclosed that Intel is also planning to offer these two MPUs in plastic, and is reviewing its pricing on them.

# MOST WANTED

## S100 MICROMODULES: AFFORDABLE, COMPATIBLE, EXPANDABLE...

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Ideal starting package. Uses DGZ80 CPU, DG640 VDU, RCA Keyboard and comes complete with manuals and programming course. S100 based system needs no special interface to expand to any configuration. Don't be fooled with single board imitations, the Instructor 80 is fully software supported with basic, assembler, games and even Pascal and CP/M!

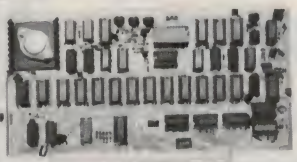
IN–Z80–K INSTRUCTOR 80 KIT **$399.00**

**DGZ80 Z80/S100 SINGLE BOARD COMPUTER:**

Most popular Z80/S100 SBC in Australia. Features Z80 CPU, PIO, CTC for powerful I/O and timing, 2K ROM/2K RAM on board, 2 or 4 MHZ operation. With DGOS Monitor in ROM the DGZ80 needs only a keyboard and DG640 VDU for minimum system.

DG-Z80-2K 2MHZ DGZ80 KIT **$199.00**
DG-OS-1.4•DGOS MONITOR IN ROM **$40.00**

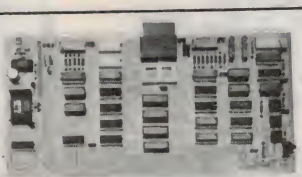
**DG640 VISUAL DISPLAY UNIT:**



This super functional S100 PCB is an industry standard. Generates 64 characters per line, 16 lines per page, full upper/lower case and graphics. Built in crystal time base locks onto TV sync. Watch out for outdated "El Cheapo" 32 character/upper case only displays, they just don't suit most software requirements...

DG-640-K DG640 KIT **$149.50**

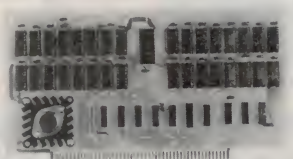
**TCT PCG HIGH RESOLUTION GRAPHICS:**



Need high resolution graphics and programmable characters? The TCT PCG option connects to the DG640 to produce 512x256 bit resolution. Supplied with StarWars and table tennis programs on cassette and has built in joy stick interfaces.

PCG KIT **$140.00**

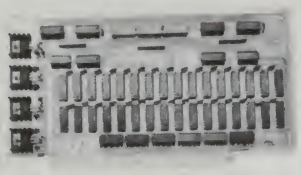
**AT16K ECONOMY 16K STATIC MEMORY:**



Just released, the AT16K uses proven 2114 static memory chips to produce a 16K block locatable ram module with write protect and bank select (port or switch controlled). AT16K is supplied burned–in and tested ready for years of trouble free service!

AT-16K-4A ASSEMBLED/TESTED AT16K (450NS) **$199.00**

**TCT 16K BLOCK LOCATABLE RAM:**



This versatile 16K ram module is configured in four independent 4K blocks each with write protect and independently locatable at any location in 64K address space. The board is fully socketed and includes dip switches for easy location.

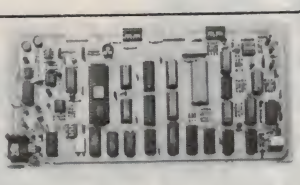
TCT-16K-K TCT16K IN KIT FORM **$209.00**

**2650/S100 SINGLE BOARD COMPUTER**

Released at last this top class design now brings the 2650 to the S100 bus. Feature laden board contains 2650 CPU, 8255 PPI, serial and parallel ports, on-board ram (to 4K), on-board rom and bank select facility to address up to 512K. The 2650/SBC is available in kit form or as a PCB with manual and control ROM.

SBC-2650-K 2650-SBC KIT WITH MANUAL **$209.00**
SBC-2650-SK 2650-SBC PCB/MANUAL/ROM **$80.00**

**SCVT S100 SERIAL VIDEO TERMINAL**



Described in EA Oct 1980, the SCVT uses the Thomson-CSF VDU Controller to produce this versatile serial terminal. Features on board UART with BAUD rate generator (50 to 1200), cassette interface, RS232 and current loop working and accepts ASCII encoded keyboard to output to monitor or modified TV set. Format is 64 characters/16 lines and attributes include reverse or flashing characters, cursor abbressing and hardware scrolling. With a keyboard such as the Clare C70, and a suitable TV set, the SCVT becomes a cost effective "Dumb" terminal suitable for many microprocessor applications.

SCV-T100-K SCVT TERMINAL KIT **$189.50**

Full product descriptions and specifications are detailed in our 1981 catalog (see ETI March 1981). Note that prices quoted include sales tax. Please add $4.00 to cover packaging and registered postage.

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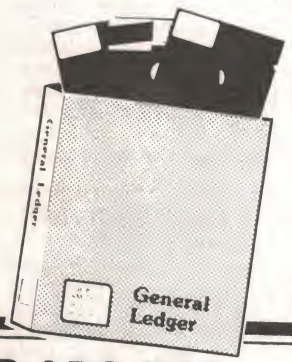
- Fully interactive with Accounts Payable. (Coming soon).

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INTRODUCING

## MENSA G.F. 1000

### BASIC SPECIFICATIONS

CPU 8080 and Z80 operating at 4MHZ. 64K bytes Dynamic RAM expandable to 2MB storage bytes of unformatted data on two double density drives. Optional external hard disk storage can be connected using the optional S-100 Bus. Floppy Disk. All modules mounted to base. CRT in a rigid aluminium frame. Disk Drive assemblies are mounted into special brackets for ease of servicing.

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26MB of Winchester Disk complete with controller and easy backup. Disk has special capacity to only back up files accessed during the last period. Disk operating system CP/M.

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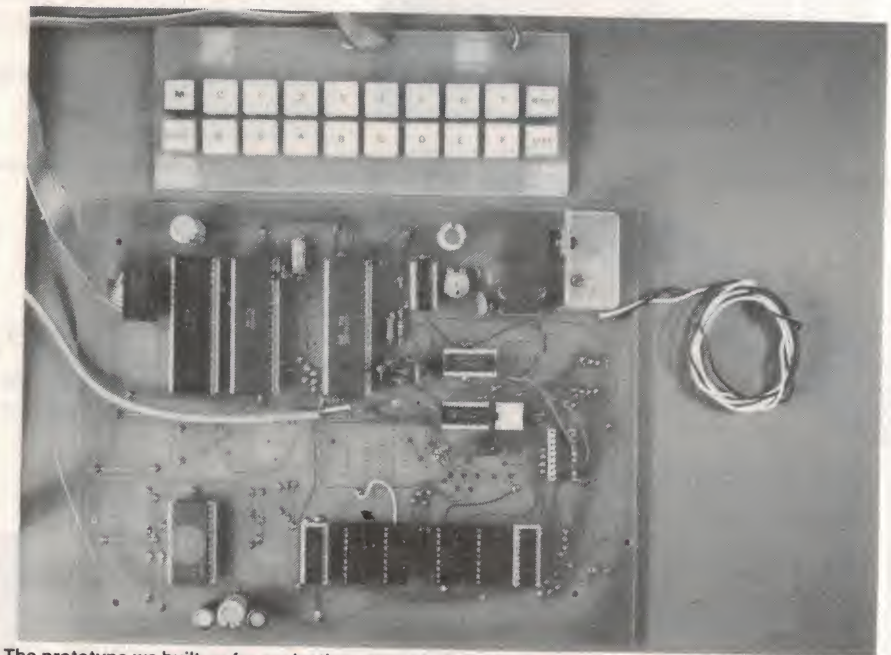
Mensa computers provide a service network throughout Australia at major service centre locations to minimise response time to service calls. To ensure that equipment will operate at peak performance, engineers and technicians are trained to ensure the highest possible standard of service.

# Want to get into microcomputing without boiling your brain cells or breaking the bank ?

## Part 1

We often receive letters from readers that say "... I want to get into microcomputing but can't afford hundreds of dollars and don't have an engineering degree". When approached with this project, we knew that here was an answer. This project is not a 'toy' or anything like an 'evaluation kit', yet is inexpensive and simple to build and get going. It was designed by Hugh Anderson and developed for publication by Graeme Teesdale, both of whom hail from the land of the kiwi and the great white cloud.

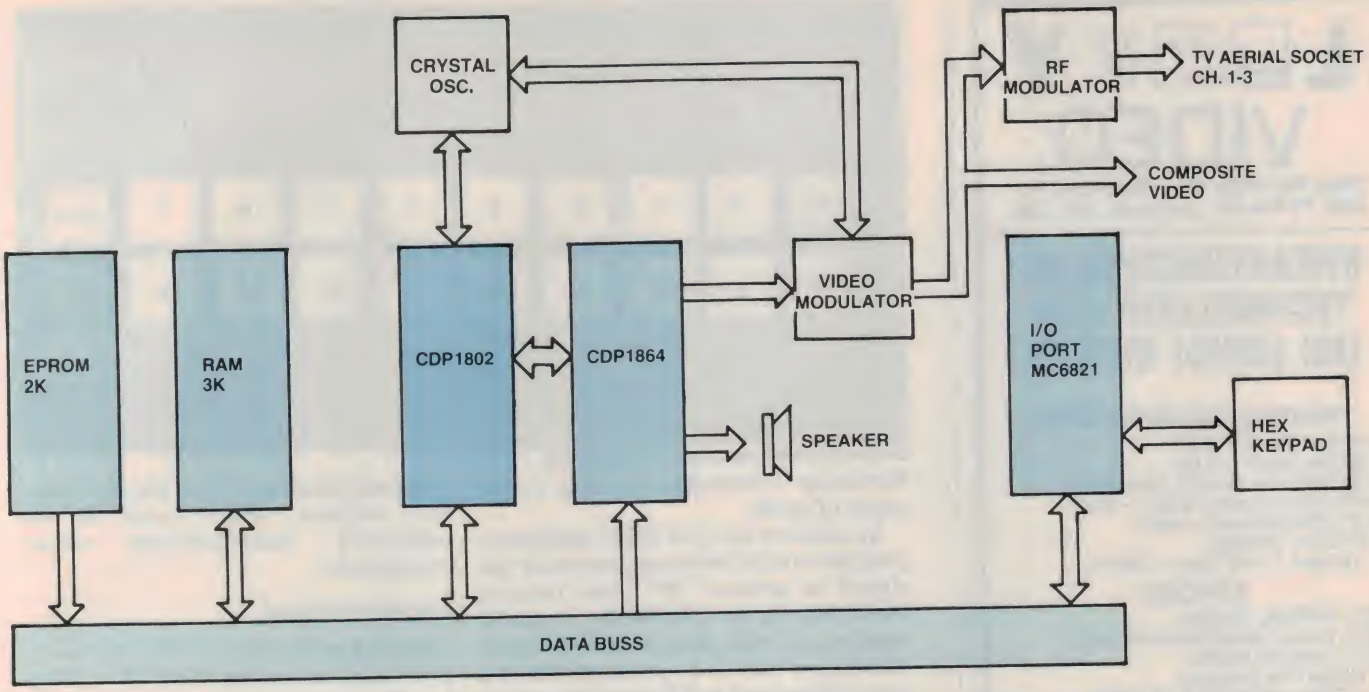
SINCE MICROPROCESSORS appeared, the concept of having a personal computer to do one's bidding has firmly taken hold in many people's minds. Electronics enthusiasts generally have a different motivation in that they're interested in the technology as well as what it will do. But the price of getting involved is generally pretty high and the level of knowledge required up front is generally pretty high too. Whilst you can buy an up-and-running computer for around $300 (the Sinclair ZX80), involvement with the hardware is minimal and many enthusiasts seek to build a computer from a kit. We've described computer projects in the past and it's possible to make up a functioning system from our ETI-680 CPU board with the addition of some peripheral hardware; the cost is around $400 but this presents a barrier to many otherwise interested enthusiasts. There are other kits around, but the price is much the same or can extend to two or three times that.



**The prototype we built up for evaluation, debugging and further development. At top is the re-arranged hex keyboard designed to make data and program entry easy — it's also great when playing games! The final unit has a somewhat larger pc board which includes an RF modulator.**

The 'evaluation kits' marketed by various microprocessor manufacturers are a less expensive alternative, but are intended for engineers and technicians and a certain level of knowledge and experience is assumed in their presentation. They also have a number of other limitations that cause many enthusiasts to shy away from them.

This project is aimed at people wishing to make a start in the microprocessor field, but who have no real idea where to begin. That 'dream' computer is here. The basic unit is constructed on a single pc board, but provision for expansion units — such as additional memory, standard keyboard, etc — has been included. The basic unit provides for data and program entry from a hex keypad and either a standard type or one we've especially designed for user convenience may be used. Video




can be taken direct to a monitor, or RF output from an on-board modulator can be plugged directly into the antenna of a TV set tuned to channel 1. A cassette interface is provided on board and any standard cassette recorder and tape may be employed to permanently save programs. Colour video can be obtained with the addition of further components to the basic board. An audio output, via a small speaker, is provided and is used to give an audible 'prompt' when operating the keypad. In addition, it is possible to play tunes and provide games sound effects.

Following is a general technical explanation and description of the project.

## The microprocessor

The Computer is a versatile single-board mini-computer using an LSI COS/MOS CDP1802 microprocessor. This is one of two produced by RCA and is an eight-bit register-oriented central processing unit. Its main advantages are low power consumption and a wide operating voltage range of 4-10 volts.

However, one of the side effects of the low power consumption is its slow-speed machine cycle; the oscillator input frequency is 1.773 MHz to the CDP1802, machine cycle duration being approximately 4.5 $\mu$S. However, this apparently slow speed is counteracted by efficient software design.

The CDP1802 has a total of 91 easy-to-use machine code instructions, and to speed up writing programs a resident CHIP-8 language interpreter is located in EPROM.

A saving on hardware is achieved by locating the monitor and CHIP-8 interpreter in memory location 0000 to 0400. To start the monitor program running the on-board RESET button is depressed; when it is released the processor resets some of the internal registers and looks to address 0000 for the next instruction. There is thus a saving in the hardware necessary to bootstrap the processor to some other area of the memory map, e.g: 8000 to 81FF, as in some other systems. The following is a memory map for this computer:

| | | |
|---|---|---|
| 0FFF<br>0C00 | — | additional user RAM |
| 0BFF<br>0800 | — | additional user RAM |
| 0700<br>0600 | — | program storage area in RAM |
| 0500<br>0400 | — | video display memory — variables and scratchpad |
| 0300<br>0200<br>0100<br>0000 | — | monitor and CHIP-8 interpreter located in EPROM |

The user RAM is standard 2114 RAM, the final design being expanded to 3K RAM and 2K of EPROM on board. The use of the more expensive CMOS 2114 RAM will result in a lower total power consumption, and using a total of 3K standard RAM and other COS/MOS devices the total load current for the complete project is around 400 mA. This low power consumption allows the use of a simple power supply driven by an ac plug pack — no lethal 240 V mains to connect up!

Using the cheaper 2K 2716 EPROM only a single 5 V supply is required. Only 1K of the 2716 is used at this stage, but a 'tiny BASIC' is at present under evaluation.

*● This project was originally developed by Hugh Anderson for Kitparts N.Z. and known as the 'HUG 1802'. Graeme Teesdale, working in ETI's laboratory, has further refined it in conjunction with advice from Hugh, and prepared it for presentation as an ETI project, number ETI-660.*

## Features

RCA produce a wide range of buss-compatible devices for use with the CDP1802. For this project we have selected the CDP1864C, an LSI CMOS colour or black and white PAL-compatible video controller. The CDP1864C generates vertical sync, horizontal sync and composite sync. These signals combined with the RED, BLUE, GREEN, BURST and BACKGROUND output signals can be used to generate a composite video signal for a video monitor or into our RF modulator to your TV aerial inputs. The DMA (Direct Memory Address) feature of the 1802 is used for direct data transfer of luminance information for display refresh.

The completed toy computer with additional components added to the motherboard and under program control will produce limited background and foreground colours, but sufficient ▶


Close-up of the re-arranged hex keyboard.

flexibility is available to satisfy a wide range of needs.

In addition the CDP1864C contains a programmable frequency generator designed to produce 256 tones ranging from 107 Hz to 13 672 Hz. A small speaker is driven from the AUD output, allowing a tone to be produced when a key is depressed and the computer is in the tape load/dump routine. This generator can be used with suitable software in users' programs.

To produce the correct line and vertical sync pulse periods, a crystal frequency input of 1.75 MHz is required to the CDP1802; conversely, to produce the correct colour phase angles, a reference of twice colour-burst frequency is required by the colour modulator circuitry. Considerable attention was given to this area in an effort to reduce the crystal count to one. The frequency of the colour burst is far more important than the line or vertical frequencies, and most video or TV receivers have at least a 5% catching range about their nominal frequencies. A decision was therefore made to use the more commonly available 8.86 MHz crystal, which was divided by five to produce a frequency of 1.773 MHz. The error when compared to the original 1.75 MHz is slightly over 1%, and results in a vertical sync frequency of 50.6 Hz and a line frequency of 15 820 Hz. The only effect on screen is the 0.6 Hz beat pattern on the picture if an older monochrome receiver with a poorly filtered power supply is used. In modern colour TV receivers the effect is not noticed due to the improved power supply designs. The cost saving of not having the additional crystal and TTL oscillator outweighs any disadvantages encountered.

In practice it is difficult to obtain a symmetrical output divide-by-five to drive the clock input of the CDP1802. We experimented with different circuits until we discovered that the CDP1802 would accept an inverted non-symmetrical output from the divide-by-five sections, which saved us the additional pulse-doubling circuit components.

## Input/output

The most commonly used I/O port is the RCA support device CDP1852, which has the disadvantage of not being software programmable to be input or output; the CDP1851 does not have this disadvantage but is more expensive. The more commonly available Motorola MC6821 Peripheral Interface Adaptor (PIA) was therefore chosen for the I/O port. The basic system uses only one of the two eight-bit bi-directional ports, the other being user-available, although only using machine language programming.

The PAO-PA7 section of the PIA is used to interface the hex keypad to the CPU, the other PB section not being initialised in the monitor program. The 6821 PIA is normally memory-mapped in the 6800 system, a combination of the decoded address lines and the 1802 encoded 'N' lines being used to select it for software programming.

The PIA allows a high degree of flexibility, but does require some initialisation software in the monitor for it to act as a keypad reader. Our design is arranged so that no load key is required in conjunction with the keypad to debounce keys. An audible tone is an indication of a key being depressed.

## Whetted your appetite?

Construction details of this brilliant little computer will commence next issue, so clean up your soldering irons and clear a space on the workbench, kitchen table, etc. Following the construction we intend to present an article or two on programming along with a few already-developed programs that you can play with. Now you can learn about the ins and outs of microprocessing without boiling your brain cells or breaking the bank. Don't go away! ●

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# THE HUG 1802 MICROPROCESSOR

Introducing

Developed by our parent company in New Zealand to allow the hobbiest to get into microprocessors at minimal cost.
This simple single board microcomputer has already become the top selling micro kit in New Zealand — thoroughly tested and proven over the last 8 months.
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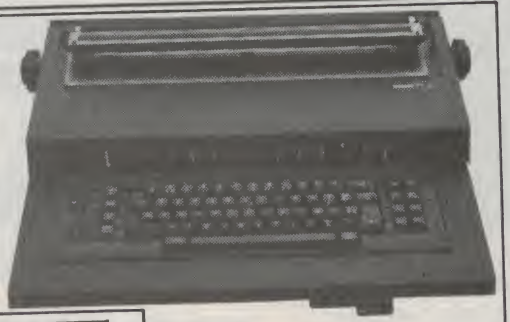
How good is it? - This part of our advertisement was typeset using an ET-121 driven by a TRS-80. Write and ask for full details.



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**Comparison Chart**

| Parameter | Syst. 80 | TRS-80 |
|---|---|---|
| CPU Type | Z-80 | Z-80 |
| Speed | 1.7MHz | 1.7MHz |
| S-100 Compatible (with expansion unit). | Yes | No |
| RAM (basic computer) | 16K | 16K |
| Built-in Cassette Recorder | Yes | No |
| Built-in Video RF Modulator | Yes | No |
| Capacity of BASIC ROM | 12K | 12K |
| Cassette Recorder Ports (basic machine). | 2 | 1 |
| Motor Control for Cassette Recorders. | Yes(2) | Yes(1) |
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* The Basic System 80 costs only $750. As this computer can connect direct to your TV set a video monitor, as a separate entity, is not required: making the saving on TRS-80 prices even greater!

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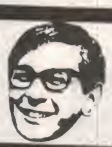

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DSE-766 AD

# Universal logic: more potential in the chip

C.L. Boltz

Will we see the thousands of logic chips shrink to one small 'universal' set? If Dr Stanley Hurst of the University of Bath can translate his theories into practice a revolution in logic circuit design may well be sparked off.

MOST SILICON CHIPS are cheap because they embody conventional circuits of the sort generally needed in electronic equipment and are mass-produced. Many others are needed for special applications, but making small batches of chips designed to do specific, less commonplace jobs is complicated and expensive. A new approach to this problem, based on what is called universal logic, is a design for a chip with the potential of virtually any kind of computer-logic circuit and which can be used as a 'universal' building block in electronic systems.

A new and highly original line of development in microelectronics is being pioneered by Dr Stanley Hurst, a senior lecturer in the school of electrical engineering at the University of Bath, in the west of England. Dr Hurst's early work in universal logic, as it is called, was supported by the UK Science Research Council; now the Wolfson Foundation has made a grant of STG£127 000 (A$254 000) to turn the theory into practical devices.

Closely associated with this research, but with its own money, is Silicon Microsystems, a small microelectronics company based 30 or so kilometres away in Malmesbury. The company's part is the practical and commercial aspects of design. Dr Hurst says that one aim of the partnership is eventually to become a national centre for designing microelectronics devices of the sort that will not be sold in the usual vast numbers.

Microprocessors (computer control processors on tiny slivers of silicon) are cheap and plentiful, but they are so only because of immense sales. The range available from the world's manufacturers is relatively inflexible, which means that users have to surround the microprocessor with other integrated-circuit devices to get the operation they require. So there is already a market, one which will increase in the 1980s and onwards, where makers of equipment need *specific* digital microelectronics devices designed to their individual needs. The difficulty here is that the cost of designing a silicon-chip device is enormous, involving many highly skilled scientists and engineers over a very long time, even with computer-aided design, and needing very complex and expensive equipment. This huge cost is quickly recovered when there are large, world-wide sales, but such a project cannot be considered by an equipment manufacturer who needs but one or at most a few types of special digital devices designed for his particular application.

Dr Hurst and Silicon Microsystems are not the only ones to see this. The British firm of Ferranti has already won a Queen's Award for technology for what it calls its uncommitted logic array, based on blocks of conventional circuits already incorporated in each chip but not connected to each other until the customer's needs are known.

Dr Hurst's approach is quite different. Though, as he says, there has been and will continue to be tremendous development in designs and manufacturing techniques, there has not been much "evolution or revolution at the fundamental level". If there were a general-purpose basic design, needing only the final masking procedure for arranging the interconnecting links to make a device to suit a specific purpose, the small-quantity market could be satisfied economically. So he has researched what he calls his Universal Logic.

In this context, logic is the application of Boolean algebra to a digital process using binary arithmetic. Boole was an English logician and mathematician who wrote a paper on the mathematical analysis of deductive reasoning in 1847, a paper re-discovered in 1938 and applied first to relays and switches. It was seized on in the mid-1940s for electronic computing. It is a sequence of decisions of 'go' or 'not-go', or 'on' or 'off' or, in the language of Boole, 'true' or 'false'. A computer and any similar digital device is an immense multiplicity of electronic switches, known as 'gates', which pass on binary information (that is, a 0 for 'off' and a 1 for 'on') from one or more input signals.

## Orthodox gates

Among the orthodox gates used in all digital computers and circuits employing logic there are four that are by far the most common. The simplest is probably the AND gate. In this, if there are two inputs, A and B, when both are 'on' or represent 1 in binary arithmetic the output is also 1. If either A or B is not on (that is, represents a 0) the output is a 0. Another is the OR gate. In this, if there are two inputs, A and B, the output ▶

| Inputs | | All possible output functions $f(x_i, x_j)$ | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $x_i$ | $x_j$ | $f_0$ | $f_1$ | $f_2$ | $f_3$ | $f_4$ | $f_5$ | $f_6$ | $f_7$ | $f_8$ | $f_9$ | $f_{10}$ | $f_{11}$ | $f_{12}$ | $f_{13}$ | $f_{14}$ | $f_{15}$ |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |

**Table 1. Functions which can be obtained from various gates with two inputs. For three input variables there are 256 possible output functions.**

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is 1 if either A or B is 1, or if both are 1. There is also an inverter or negator gate which inverts a single input, so that a 0 becomes a 1 and a 1 becomes a 0. Combining an inverter with an AND gate makes a NAND gate; an inverter with an OR makes a NOR gate. Generally speaking, for reasons of electronics, NAND and NOR gates make up the bulk of the logic of a digital system.

## Lacking power

From the evidence of digital computing it must be agreed that these gates have been very successful, but analytically they do not satisfy Dr Hurst. In his words, they lack logical power. It is easy to see that there is an ambiguity in each gate. With an AND gate, for example, accepting inputs A and B, we can say that when one input is in the off state and the other in the on state the output is 0, but it does not indicate which one of A and B is off or on. With three inputs things are even more ambiguous. To put it another way, the output of an NOR gate is unique only when all inputs are 0, and of a NAND gate only when all inputs are 1.

The practical outcome of this lack of logical power is that quite a number of gates have to be combined to give a specified result. For example, in one simple device adding numbers there are 16 gates. A straightforward decoder (which translates from binary to ordinary decimal numbers, among other tasks) needs 50 gates to do its basic job. A circuit to compare one number with another has 33 gates. (These figures are taken from a random look at some published circuits.) In a microprocessor there may be at least 3000 gates.

The inefficient way orthodox gates operate Boolean logic has set more than one microelectronics engineer or scientist thinking of possible better circuits, but large manufacturers have had such enormous success in getting thousands of gates on a silicon chip, making it a cheap device, that they are interested only in competitive technological improvements in getting more and more on less and less. There is no reason why they should be interested in fundamental changes in logic. In the market for small-quantity, custom-built chips things are different.

## Mathematical

The approach of Dr Hurst and his colleagues is fundamental yet unconventional. In trying to find out whether one could get a basic circuit that would do whatever logical step was needed, according to the connections and the programming, their thinking was primarily mathematical: it made use of esoteric techniques such as set theory, Walsh functions and so on. They were able to show that a universal logic gate was indeed a possibility. With two input variables there are 16 possible output functions (see Table 1, which is an exercise to see what functions could be obtained from various gates). For three input variables there are 256 possible output functions. Could a single circuit cope?

Calling the circuits ULG2 (universal-logic gate for two input variables) and ULG3, Dr Hurst has shown that an array of ULG2 gates will do all the logical steps possible even for three input variables and that one ULG3 will be capable of realising all 256 outputs — not all at once, of course, for the result depends on which input terminals are used and how the circuit internal wiring is connected.

The number of ULG2 cells needed to realise all the 256 functions of three input variables has been calculated and compared with the equivalent figure for orthodox gates. The results are shown in Table 2. We can see that the ULG2 is roughly twice as powerful as a NAND or a NOR. Incidentally, it should be noted that although a ULG2 may have only two independent variables as input, there may be three or four physical connections. Figure 1 shows a circuit for a ULG2. It has two transistors, two diodes, and three resistors. Though there are but two input variables, there are three input connections. This is to do with the set-theory mathematics of the device and need not concern us.

| | ULG2 | NAND | NOR |
|---|---|---|---|
| Total number of cells or gates to realize all 256 functions | 683 | 1118 | 1124 |
| Average number per function | 2·67 | 4·36 | 4·39 |
| Maximum number per function | 4 | 7 | 7 |
| Average number of cell/gate connections per function | 10·68 | 17·44 | 17·56 |

**Table 2. Comparison between the capabilities of ULG2 cells and those of orthodox gates. The table shows that the ULG2 is roughly twice as powerful as a NAND or a NOR gate.**

The electronics of the circuit need not be considered in detail. A gate is made of transistors, diodes, resistors and, sometimes, capacitors. Up to now most logic gates have depended on bipolar technology, that is, transistors with two possible states. This is the one represented in the diagram. A newer technique is based on MOS (metal-oxide-semiconductor) devices, which involve far fewer states in manufacture and avoid the 'cross-talk' between adjacent conductors. Silicon Microsystems is very much committed to MOS technology and Dr Hurst considers that bipolar methods will die out in the next decade and be replaced by MOS circuitry.

The practical problem is concerned with how big an area of silicon is used up in a ULG as compared with orthodox gates. It is easily seen that a ULG3 would occupy much more space. So is it better to use an array of identical ULG2s or rely on a ULG3? These are the questions being looked into at Bath now. The answer may be a compromise. When such matters are decided there will be available a set of universal logic gates which can be supplied as units. All that the designer then has to do is produce a suitable mask, a task made simple by computer-aided design, which will deposit the appropriate interconnections on the chip. The cost of design for a custom-made device will therefore be drastically reduced, even if the ULGs are themselves more expensive than orthodox gates — another question being researched.

Furthermore, as Dr Hurst has said, a considerable amount of special logic design in ULG form can be undertaken and a library of standard interconnection details built up, ready for individual customer requirements. It is a long-term research development programme for which full-time staff will be recruited. It could lead to a commanding position in the ever-growing use of silicon chips for specific purposes. ●

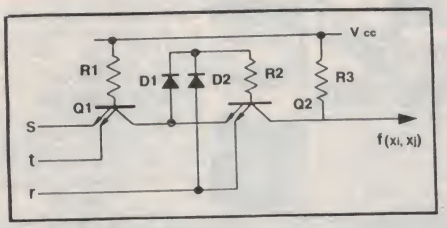
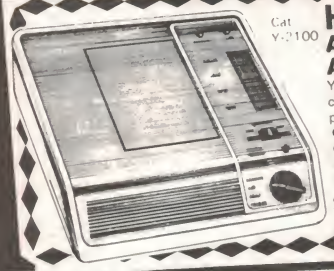



*Figure 1.* **Basic circuit of a ULG2, comprising two transistors, two diodes and three resistors. Although only two input variables are applied, three input connections (s, t and r) are provided. This is to do with the set-theory mathematics of the device.**

# HEY EXPERIMENTERS...LOOK AT THIS!



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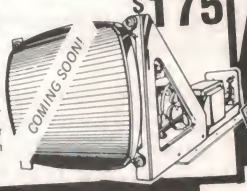


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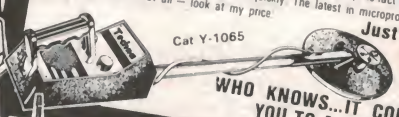

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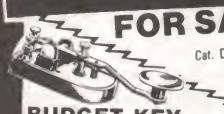

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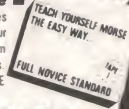


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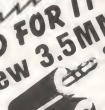

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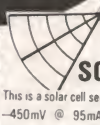
Cat. F-4610

## GREAT NEW SOLAR CELL!



This is a solar cell sector with a very high output –450mV @ 95mA (45mW per cell). Join them together for higher outputs in voltage & current. The versatile 60 degree segment can be joined together to form a 60mm dia. circle ( in 6 parts) with over 2.5 volts output! What's more, IT'S EASY TO SOLDER TO! Think of the applications!!! Z-4830

$2.50

## PARTS FOR NEW KITS

See also our advert elsewhere in this magazine with new kits since our last catalog.

**HOT CANARY (See EA May)**
Complete kit, inc inst ..... K-3395 ..... $14.95
PCB only ..... H-8396 ..... $2.25

**SPEED SENTRY (See EA May)**
Complete kit, inc. inst. ..... K-3245 ..... $11.75
PCB only ..... H-8399 ..... $1.95

**INFRA RED REMOTE CONTROL (See EA May)**
Full kit, inc inst. ..... K-3380 ..... $63.95
PCB only ..... H-8397 ..... $6.95

**dB METER (See EA May)**
Complete kit, inc inst. ..... K-3476 ..... $34.50
PCB only ..... H-8398 ..... $2.35

**UHF TV DOWNCONVERTER (See ETI May)**
Full kit, inc inst. ..... K-3235 ..... $32.50
PCB only ..... H-8637 ..... *

**UNIVERSAL RELAY DRIVER (See ETI May)**
PCB only. ..... H-8638 ..... *
(All parts for this kit are normal stock lines)

**SYSTEM 80/TRS 80 SERIAL INTERFACE (See EA April)**
Full kit, inc. inst. ..... K-3608 ..... $57.50
PCB only. ..... H-8394 ..... $7.95

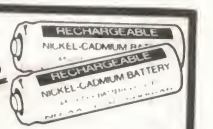
**INFRA RED BEAM RELAY (See EA April)**
Full kit, inc. inst. ..... K-3375 ..... $37.50
PCB only ..... H-8395 ..... $3.95

**CORE BALANCE RELAY (See ETI April)**
Full kit, inc. inst. ..... K-3315 ..... $49.50
PCB only. ..... H-8635 ..... $4.50

**NEGATIVE ION GENERATOR (See ETI April)**
Complete kit, inc. inst. ..... K-3335 ..... $41.95
PCB only ..... H-8634 ..... $3.95

(Above prices & dates are from magazine estimates only. We cannot guarantee that the articles will appear when specified. * Price unavailable at time of going to press).

## NEW NICADS




*Want to save a heap on batteries? Try these value-packed NiCads! They're dearer at the start, but you can charge them over and over again!*
*And now we have 'C' & 'D' size NiCads, too: at bargain prices! So why not up-date now and start saving!*

*NOTE: 'C' & 'D' NiCads come in packs of two; 'AA' size Nicads are supplied individually.*

**'C' SIZE 1.2Ah** ..... Cat. S-3302 **Pk 2: $7.50**
**'D' SIZE 1.2Ah** ..... Cat. S-3304 . **Pk 2: $7.95**
**POPULAR 'AA's** ..... Cat. S-3300 **Each $2.05**
**Save more if you buy in bulk!!!**

## NICAD BATTERY CHARGER

Great for charging anything up to 12 volts! Will charge from six to ten 1.2 Volt batteries at a time. The current automatically adjusts. FULLY APPROVED and it's only

Cat M-9517

$11.50

## HOT TRANNIES?

Our heatsinks will give the best heat transfer for your money! And you'll save even more on bulk purchases!

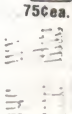
**HI EFFICIENCY POWERSINK**
For those big jobs... Mounting surface temp. rise above ambient 60°C @ 30W heat diss.
75mm H-3422 ..... $3.50ea.
225mm H-3426 ..... $9.50ea.

**TO-3 POWERFIN**
Best possible heat diss. in smallest possible space. Thermal rating approx. 5°C/Watt.
Cat. H-3400 ..... $1.25ea.

**UNIVERSAL ALUMINIUM**
Universal hole pattern allows mounting of almost all power semiconductors.
Cat. H-3401 ..... 98¢ea.

**MINI ALUMINIUM**
Ideal PCB mounting suits transistors, SCR's, Triacs etc.
Cat. H-3402. ..... 75¢ea.

**VERSATILE POWERSINK**
Mount flat or end on. Has side groove fins for multiple connection. Accepts 2 x TO-3's.
Undrilled: H-3460 ..... $5.50ea.
Drilled: H-3461 ..... $5.95ea.



## OUR SWITCHES ARE BEST!

**Our most popular switches. Low in cost, high in quality. Ideal for many applications.**

**DPDT Sub Mini Slide Sw.** S-2010 ..... **40¢ea**
**SPDT Toggle.** 240VAC 1.5A ..... S-1173 ..... **$1.45**
**SP Mini Push Button.** Nor open ..... S-1102 ..... **45c**
**DPDT Toggle Sw.** 240VAC 3A ..... S-1393 **$2.75**

We have micro switches, pushbuttons, rotary switches, illuminated switches, PCB DIL switches & MUCH MORE! Compare our prices. You'll save even more if you buy in bulk!

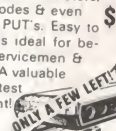
## DROP IN & SEE OUR HUGE RANGE!

## TEST IT!

Tests bipolar transistors, FET's, diodes & even SCR's & PUT's. Easy to build & is ideal for beginers, servicemen & schools. A valuable piece of test equipment! Cat. K-3052

$19.75

## LOVELY NEG IONS




Mountain air in your office? Yes – with this negative ion generator. Get rid of bad smells, dust & other particles. Doesn't produce harmful Ozone

Cat. Y-9000

$85

## 12V FLUORO $12.50

Take anywhere portable fluoro light comes complete with cigarette lighter plug. Use a a map reading light, for the caravan boat, garage etc. Versatile and inexpensive

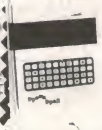
Y-1082

## 'MIX' MASTER

Well...not quite, but this unit can mix 4 signals (mic, tuner, T'table etc) into 1 signal for amp or recorder. Cat. F-2272

$14.95

## Learning has never been so enjoyable...



**SPEAK & SPELL** It actually talks! Develop your child's skills in spelling, pronunciation & reading. The unit pronounces the word while the student keys in the spelling. It tells you if you're right or wrong & even keeps a score! Has a vocabulary of over 200 most commonly miss-spelt words. Complete with 32 page guide

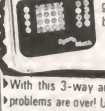
Cat Y-1300 **$79.00**

**SPEAK & READ**
Develop your child's vocabulary, word meaning & reading comprehension. Offers 6 games & activities to play. Use alone or with friends. Makes it ideal for migrant English education! Complete with 64 page book. 'You can Read!'

Cat Y-1313 **$99.00**

**SPEAK & MATH**
The microprocessor IC in this unit can generate over 100,000 maths problems & talk to you, giving you a problem & telling you if you're right or wrong. Added games make learning fun. Supplied with 32 page book 'Math Talk'. Each unit has a battery saver device.

Cat Y-1310 **$89.00**



## SWITCH IT! FILTER IT!

With this 3-way antenna switch, your problems are over! Use up to 3 antennas for your CB/Ham radio. Handles 150 watts at 30MHz. Ideal for base or mobile use! Cat. D-5206

$11.75


Cat. D-7082

$6.50

You may be annoying your neighbour by interferring with his TV set! Save yourself the hassle (& perhaps a broken nose) with this low pass filter. 30MHz cut off, low loss, 50 ohm

## WOULD YOU LIKE TO WORK WITH US?

**Dick Smith Electronics is expanding– if you've been watching your local press you'll probably have noticed this already!**

**Opening new stores requires new staff. Good staff. Electronics enthusiasts who can be trained to become professional sales people and managers.**

**If you're talented and enthusiastic, we offer good wages and conditions. If you're above average, promotion can be very rapid. (One of our salesmen became general manager three years later!)**

**No matter what area you live in, if you'd like to work with us, drop us a line. When we open a store in your area, we'll be in touch . . .**

**Send your application to:**
**The Personnel Manager,**
**Dick Smith Electronics Pty Ltd**
**PO Box 321,**
**North Ryde, NSW 2113**

## WOULD YOU LIKE TO BE A DICK SMITH RE-SELLER?

How would you like to join the hundreds of successful Dick Smith re-sellers, spread right across Australia?

If you're interested, why not give our wholesale division a call – Sydney (02) 888 3200, 9AM – 5.30PM weekdays.

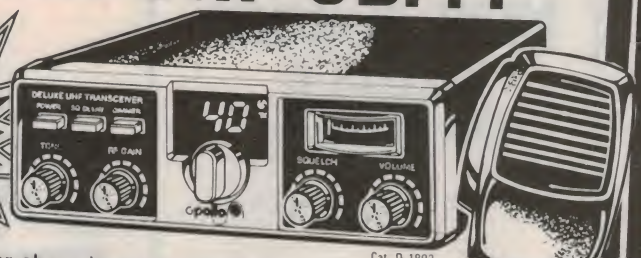
**It could be the start of something big . . .**

# A NEW GENERATION IN UHF CB. . .

## The deluxe Apollo 40 ch UHF Transceiver

Until now, you've really had no choice in buying a UHF transceiver. With the new Apollo AP400 you'll surprise your contacts with a good clear sound – standing out from the crowd. This amazing breakthrough in UHF technology makes it ideal for small busines or rural applications. Great for use in the car on the way to work or as a home installation. On air signal is strong and clear while the powerful receiver has a high selectivity to eliminate cross channel interference

$379




Cat D-1802

### Just look at these features:

- Large illuminated SRF meter.
- Delayed action squelch circuit.
- RF gain control.
- Tone control
- Green LED channel indicator for sharp image – even in daylight!
- Dimmer switch
- Performance you just couldn't find in less expensive equipment.

## It's got to be the best ever so far... 12 LEVEL CHESS COMPUTER

This magnificent and attractive unit has 12 different levels of skill enabling you to learn gradually It even plays against itself! A must for any professional or serious chess player You'll have to see for yourself the number of incredible features it has.

Cat. Y-1256

**Don't pay $1000 or more – our price is only:**

**$245.00**

*Complete with chessmen and power supply!*

## PROTECTION... COMUNICATION...

$59

Take with you anywhere VHF reciever Has 6 bands including AM FM CB AIR POLICE TAXI & much more Its unique tuning meter also acts as a battery indicator Comes complete with earphone jack & VHF listening guide Cat D-2833

Too many intruders? This unit won't let them pass the door If they try, they'll encounter a piercing siren Also features pleasant ding dong sound – so you don't scare your friends The 15 buttons enable you to pick your own secret code, so you can switch it off when you get home

**$29.50**

Cat L-5100

## OOPS!

**Catalogue Correction**

Due to an oversight, the price and catalogue number for a discontinued printer were shown on page 6 The correct catalogue number for our new low-cost printer is X-3252 and the price is $495.00

Our apologies for any inconvenience caused

**Dick Smith & Staff**

## Learning to play Chess?

Improve your skills with this Chess Master learning aid. You can soon play like a professional! Solve problems in the least number of moves. Play alone or with others and experience the different tactics and checkmates etc. Complete with 7 booklets each containing 50 moves – that's 350 moves to play!

**$35.00**

Cat Y-1257

## WHOLESALE MAIL COMPETITION PRIZE WINNERS

Thanks to all who entered our 'wholesale Give-away' competition for a fabulous System 80 computer and other great goodies We received thousands of entries

**Congratulations to:**

**Graeme Ryder:** Jindabyne NSW – 1st prize Dick Smith System 80 16K personal computer

**Stephen Morton:** Nightcliff N.T – 2nd prize Dick Smith Telephone Answering Machine complete with remote beeper

**Colin Laidley:** Coffs Harbour NSW – 3rd prize Sanyo Stereo Cassette Deck with Dolby Noise reduction

PLUS 100 FUNWAY VOLUME 2 BOOKS GIVEN AWAY!!!

Once again, thanks to all who participated

**Dick Smith & Staff**

## FOR THE LOVE OF BOXES!

Superbly made folded aluminium cases in a variety of sizes; fitted with rubber feet and have ventilation slots Look really great!

| SIZE | CAT | 1-9 | 10 up |
|---|---|---|---|
| 102 x 56 x 83 | Cat H-2741 | $2.75 | $2.55 |
| 150 x 61 x 103 | Cat H-2742 | $4.35 | $3.95 |
| 150 x 76 x 143 | Cat H-2743 | $4.90 | $4.40 |
| 184 x 70 x 160 | Cat H-2744 | $5.45 | $5.00 |

## DICK'S ZIPPYS ARE BEST!

Dick Smith zippy boxes are unique: they're the ones with slotted sides allowing for easy mounting of PCB's etc. Insist on them!

| SIZE | Cat No: | 1-9 | 10 up |
|---|---|---|---|
| 150x90x50 | H-2751 | $2.50 | $2.00 |
| 196x113x60 | H-2752 | $3.75 | $3.00 |
| 130x68x41 | H-2753 | $1.95 | $1.60 |
| 85x54x28 | H-2755 | $1.50 | $1.20 |

## Our 2nd Perth store is NOW OPEN

Hey you lucky Western Aussies, you've got another store! You'll find the same reliable & friendly service and a wide range of goodies for the electronics enthusiast and professional We're just a short walk form the 'Carousel' shopping centre at the corner of Albany Highway and Wharf St Ph 451 8666 SEE YOU THERE!


## Did you miss out?

Last month EA & ETI included our FREE 1981 catalogue packed with goodies for the eager enthusiast If you missed out don't worry Just send 75c (P&P is free) to our Mail Order Centre Address below INCLUDES 30 PAGE DATA SECTION!!!

# DICK SMITH ELECTRONICS

**NSW**
- AUBURN: 145 Parramatta Rd. 648 0558.
- BLAKEHURST: 613 Princes Hwy. 546 7744.
- BROADWAY: 818 George Street. 211 3777.
- BROOKVALE: 531 Pittwater Rd. 93 0441.
- CHULLORA: 147 Hume Hwy. 642 8922.
- GORE HILL: 162 Pacific Hwy. 439 5311.
- PARRAMATTA: 30 Grose Street. 683 1133.
- SYDNEY: 125 York Street. 290 3377.
- WOLLONGONG: 263 Kiera Street. 28 3800.

**ACT**
- FYSHWICK: 96 Gladstone Street. 80 4944.

**QLD**
- BURANDA: 166 Logan Rd. 391 6233.
- CHERMSIDE: 842 Gympie Rd. 59 6255.

**SA**
- ADELAIDE: 60 Wright Street. 212 1962.

**VIC**
- MELBOURNE: 399 Lonsdale Street. 67 9834.
- RICHMOND: 656 Bridge Rd. 428 1614.
- SPRINGVALE: Dandenong & S'vale Rds. 547 0522.

**WA**
- PERTH: 414 William Street. 328 6944.
- CANNINGTON: Wharf St & Albany Hwy. 451 8666

SHOP HOURS: 9AM TO 5.30PM MONDAY TO FRIDAY; NOON SATURDAY (Brisbane stores half hour earlier). Some stores are open on late shopping nights: please phone your local store to check before coming in!

**DICK SMITH MAIL ORDER CENTRE:**
PO Box 321, North Ryde, N.S.W. 2113. Ph: (02) 888 3200.

SERVICE CENTRE: LANE COVE & WATERLOO RDS. NORTH RYDE NSW 2113. PHONE (02) 888 3200. 9AM TO 5PM. MONDAY TO FRIDAY ONLY

**PRICES CORRECT FOR MONTH OF PUBLICATION OR WHILE STOCKS LAST.**

## BUYING BY MAIL?

| ORDER VALUE: | P&P |
|---|---|
| $5 (min) to $9.99 | $1.00 |
| $10.00 to $24.99 | $2.00 |
| $25.00 to $49.99 | $3.00 |
| $50.00 to $99.99 | $4.00 |
| $100 or more | $5.50 |

NOTE These charges apply to goods sent by post in Australia only Large and bulky items cannot be sent by post.

If you prefer, we will despatch your order by Comet Road Freight to anywhere in Australia for only $7.00 that's below what it costs us! Large and bulky items are normally sent by Comet unless you specify differently (eg by rail or air – you pay freight on delivery)

## COMPUTER HOTLINE

Want to know more about our computers? Or maybe you're having problems and need advice. For friendly, helpful information on System 80 or Sorcerer computers, or on any of our peripherals, phone our Computer Hotline:

Monday – Friday, 9 – 5.30 on Sydney (02) **888 2002**

## Dear Customers,

Quite often, the products we advertise are so popular they run out within a few days Or unforseen circumstances might hold up goods so that advertised lines are not in the stores by the time the advert appears Please don't blame the store manager of staff they cannot solve a dock strike on the other side of the world, or even locate a shipment that has gone astray

What we are trying to say is that if you are about to drive across town to pick up a particular line at a Dick Smith store, why not give the store a ring first (addresses and phone numbers opposite) just in case Thanks

**Dick Smith and Staff**

## MAJOR DICK SMITH RE-SELLERS:

Listed below are re-sellers who stock a large proportion of our range. However we cannot guarantee that they will have any or all of the items, or at the same prices, as those shown here.

**ATHERTON, QLD: Tableland Radio Service**
2 Jack Street Phone 912 017

**BENDIGO, Vic: Sumner Electronics**
95 Mitchell Street Phone 431 977

**BLACKHEATH, NSW: Goodwin Electronics**
123 Station Street Phone 878 379

**BROKEN HILL, NSW: Crystal TV Rentals**
66 Crystal Street Phone 6897

**CAIRNS, QLD: Thompson Instrument Services**
79–81 McLeod Street Phone 512 404

**COFFS HARBOUR, NSW: Coffs Harbour Electronics**
3 Coffs Herbour Plaze, Park Ave Phone 525 684

**DARWIN, NT: Kent Electronics**
42 Stuart Highway Phone 814 749

**DUBBO, NSW: Selekta Sound.**
31 Talbregar Street 826 979

**EAST MAITLAND, NSW: East Maitland Electronics.**
Cnr Lews & High Streets 337 327

**FAIRY MEADOW, NSW: Trilogy Wholesale Elect.**
40 Princes Hwy Phone 831 219

**GERALDTON, WA: KB Electronics & Marine**
361 Main Terrace Phone 212 176

**GOSFORD, NSW: Tomorrow's Electronics & HI Fi**
68 William Street Phone 247 246

**HOBART, TAS: Aero Electronics**
123e Bethurst Street Phone 348 232

**KINGSTON, TAS: Kingston Electronics & Records**
Channel Court Phone 296 802

**LAUNCESTON, TAS: Advanced Electronics**
5e The Quadrent Phone 317 075

**LISMORE, NSW: Decro Electric**
Magellen St & Bruxner Hwy. Phone 214 137

**MACKAY, QLD: Stevens Electronics**
42 Victoria Street Phone 511 723

**MARYBOROUGH, QLD: Keller Electronics**
218 Adelaide Street Phone 214 559

**MORUYA, NSW: Coastal Electronics**
43 Vulcen Street. Phone 742 545

**MT GAMBIER, SA: Hutchesson's Communications**
5 Elizebeth Street. Phone 256 404

**MUSWELLBROOK, NSW: Silicon Chip Electronics**
Suite 3, 98 Bridge Street Phone 43 1096

**NAMBOUR, QLD: Nambour Electronic Shop**
Shop 4, Lowen House, Ann St Phone 411 604

**NEWCASTLE, NSW: Elektron 2000**
181 Wharf Road Phone 262 644

**ORANGE, NSW: M&W Electronics**
48 McNamara Street Phone 626 491

**ROCKHAMPTON, QLD: Purely Electronics**
15 East Street Phone 21 058

**SOUTHPORT, QLD: Amateur's Paradise**
121 Nerang Street Phone 322 644

**TAMWORTH, NSW: Sound Components**
78 Brisbane Street Phone 661 363

**TOOWOOMBA, QLD: Hunts Electronics**
18 Neil Street Phone 326 944

**TOWNSVILLE, Qld: Tropical TV**
49 Fulham Rd, Vincent Village Phone 791 421

**TRARALGON, VIC: Power'N'Sound**
147 Argyle Street. Phone 743 638

**WAGGA, NSW: Wagga Wholesale Electronics**
82 Forsyth Street

**WINDSOR, NSW: Hawkesbury Electronic Centre**
t11 George Street Phone 773 411

**WODONGA, VIC: A & M Electronics**
78a High Street Phone 244 588

**WHYALLA NORRIE, SA: Mellor Enterprises**
Shop 2, Forsythe Street Phone 454 764

**There's a re-seller near YOU!**

# NDK S-4000

## SAMPLE PRINTOUT

$$F(\omega) = aT\frac{\text{Sin } \omega T/2}{\omega T/2} e^{-j\omega T/2}$$

$$e_{RMS} = \sqrt{4KTR(f_2 - f_1)}$$

$$L_1 = 10 \log \frac{1}{80} \times S_n \text{ (dB)}$$

$$A^2+B^2=C^2$$

$$H_2SO_4 \quad H_2O$$

$$W_{xy}(f)=\int_{-\infty}^{\infty}\psi_{xy}(\tau)e^{-j2\pi f\tau}\,d\tau$$

$$L=\int_0^x\sqrt{\left(\frac{dx_1}{d\theta}\right)^2+\left(\frac{dy_1}{d\theta}\right)^2}\,d\theta$$

$$\psi_{xy}(f)=\tan^{-1}\left[\frac{P_{xy}(f)}{C_{xy}(f)}\right]$$

$$\left.\begin{aligned}a_1x+b_1y&=c_1\\a_2x+b_2y&=c_2\end{aligned}\right\}$$

$$x=\begin{vmatrix}c_1 & b_1\\ c_2 & b_2\end{vmatrix}\div\begin{vmatrix}a_1 & b_1\\ a_2 & b_2\end{vmatrix}=\frac{c_1b_2-c_2b_1}{a_1b_2-a_2b_1}$$

$$S=\sum_{j=1}^{n}X_j$$

$$\Delta f_{max}\tau_{max}\leq 0.3$$

$$|W_{xy}(f)|=\sqrt{C^2_{xy}(f)+Q^2_{xy}(f)}$$

$$\Psi_{xy}(\tau)=\lim_{T\to\infty}\frac{1}{T}\int_0^T f_x(t)f_y(t+\tau)dt$$

## PRINTER $3,190 C.O.D.

**STAND .....$160**
**SALES TAX .....$390**

# OPAL 2000C

The OPAL 2000C is an 8 slot S-100 system conforming to the new IEEE standards. The system uses a 4Mhz Z80 CPU and has 3 serial RS232c serial and 3x8 bit bi-directional parallel ports. The disk controller, is California Computer Services' multi-mode model (able to control both 5" and 8" disk drives).
Memory is provided by a 4 MHz 64k dynamic RAM Board by Measurement Systems and Control. The memory board is fully bank selectable and is designed for upgrading to a multi-user system.
Disk drives are 2x8" QUME double density, double sided disk drives with a total on line capacity of 2.4 megabytes (1.2 megabytes per 8" disk).
The system is mounted in an attractive pressed Aluminium housing with a cast front panel fitted with reset button and key operated on/off switch. The power supply is equipped with a line filter.
The operating system software is CP/M version 2.2 An extensive monitor is included. The OPAL 2000C will read and write on any of the following formats or exchange information between any combination on A and B drive:
IBM 3740 Single Density single sided disk.....240k
Double Density Single sided disk.....480-600k
Single Density Double sided disk.....480k
Double Density Double sided disk .....1.2 mbytes
**Introductory Price:** $4,975.00 plus $600.00 sales tax.

# LIFELINES

**Lifelines** is a monthly software newsletter published by Lifeboat Associates.
Although Lifelines contains features and columns dealing with new software products on the market, product comparisons, the CP/M Users Group and other items of general interest, the principal role of the periodical is to provide timely notice to owners about their software. Each month, new revisions are reported, together with information on the purpose for each such release, be it for the correction of "bugs" or the addition of features and facilities.
The software products distributed by Lifeboat Associates are frequently both complex and costly. We recommend that all serious users of software should take out subscriptions to Lifelines, ensuring that they are automatically informed about the current state of their software tools and thus get full value for their purchase.
**Subscription Costs:**
$36.00 for 12 issues. Price includes postage for anywhere in Australia.
$5.00 each for back issues. Price includes postage for anywhere in Australia.
All orders must be prepaid.

Prices and specifications are subject to change without notice.

Send $1.00 for our Hardware Catalogue which describes our complete range of NDK printers, OPAL systems and contains a summary of CP/M software.

The SOFTWARE OMNIBUS ($5.00) contains a complete description of all Software retailed by John F Rose Computer Services Pty Ltd together with user feedback and information about software versions.

# FMS-80

FMS-80 is a comprehensive file management system, designed for use by everyone from novice to advanced programmers. It is the first complete data management system for CP/M, MP/M or CDOS. The program is completely menu-driven using a set of interactive integrated component programs.

FMS-80 leads you interactively through defining file and record descriptions, making additions, deletions and corrections and generating reports from your data files. FMS-80 will help you define selection criteria, to extract information for your reports by upper and lower limits, specific values for fields, relative values among fields, across multiple files, etc.

For example: All employees between the ages of 40 and 50 who received an annual salary greater than $20,000.00.

With FMS-80, selection criteria can include logical connections between fields or among groups of fields. Reports and printed summaries are easy to produce. FMS-80 leads you interactively through its report generation program; asking questions and producing reports only with the information you request, placing data in any format on a page or across multiple pages. Thus you can fill in prepared forms and create reports to fit your own unique specifications. Using the report generator's math functions, summaries, price extensions, etc., are all readily available at print time.

File definition allows you to interactively tell the computer how to keep track of desired data. Each record of information can contain up to 255 fields with each field containing up to 255 characters. Altering field size or addition and deletion of fields allow data files to grow and change with your needs. Duplicate data entry is eliminated.

FMS-80 allows you to specify which field or fields constitute a Master key or various secondary keys. The system uses these keys to build indexes for rapid retrieval of any record in a file when performing updates or queries. Any field may be used by record selection, even though it was not previously selected and defined as a key field. Data files can be recorded into various sequences to allow display of data ordered to your specifications.

FMS-80 selection features allow you to extract data from a file using your own specifications. Data can be selected by a range of values, conditions (equal or unequal), or relations to other fields. After a record has been selected using your specifications, the data can be summarized, stored in another data file, or printed. Regardless of complexity, selection never requires more than a single pass of the file. Using the advanced features of FMS-80, program like commands allow data selection and extraction from multiple files.

FMS-80 can specify the format on the screen for data display and collection. A complete form can be outlined on the screen to ease data entry. If your data collection requirements will not fit on a single screen, you can define multiple screens in each screen definition. Through the extended file maintenance (EFM) feature, data from multiple record and multiple files can be displayed simultaneously on a single screen. In addition to the normal error checking of alphabetic and numeric type data, EFM allows specific data entry validation.

Using FMS-80 application programs or other non-related programs can be executed. Not only can a single program be invoked, but a series of programs can be linked and executed by selecting a single menu entry. (for example WORDSTAR/MAILMERGE, General Accounting Package (GAP), DATASTAR, etc., can be called from a single master menu). Application programs could be written in CBASIC (or BASIC-80) and run using FMS-80 files.

FMS-80 allows 3 methods of generating printed reports. The simplest method allows the system to format printed data in columnar fashion. With the FMS-80 report generator you can define the format of the data printed for such things as cheques, statements and order forms, or simply arrange the data the way you want it to look. Any number of "header" or "footer" lines can be defined as well as page length and width. Multiple records can be placed on a page or a single record can fill a page or multiple pages. FMS-80 will paginate, fitting the correct number of entries on each page. Using the contents of the data fields, a variety of functions can be controlled. "Header" or "Footer" substitution, new page control, math functions performed, or summary lines can all be accomplished. The most powerful report generation is accomplished through EFM. In addition to the above features, data can be drawn from multiple sources, including the terminal or multiple files.

The QUERY function allows online browsing of a data file. Any previously built indexes and/or screen descriptions may be used when retrieving data.

FMS-80's Extended File Maintenance (EFM) brings the full capability of FMS-80 under full control. EFM allows you to develop applications faster than programming in BASIC or other languages because all the complex screen and report handling functions are handled for you. Split screen formatting, multiple data file access and generation and selection are some of the features provided. Additional EFM capabilities include:

- Processing up to 20 files at a time.
- Reformatting and expanding data records and files.
- Combining multiple input files along with terminal input to produce one or more output files, printed reports or terminal display.
- Math functions including addition, subtraction, multiplication and division on fields containing numeric data.
- Control statements available when creating an EFM request include CALL, IF-THEN-ELSE, SWITCH/CASE and GOTO.
- End of file and on error conditions for the file input/output are supported.
- Extensive screen handling and printer handling are available.

**Price:** $950.00 (Quantity discounts are available).
**Formats:** Micropolis Mod II (Q2), Northstar Single/Double/Quad (P2), 8" IBM. (a1).

# Wordsquare — a game for the TRS80

A. Lacy

Simpler than Scrabble, cheaper than crosswords and more humane than Hangman, we present Wordsquare, your very own cure for insomnia.

THIS PROGRAM is designed to run on a Level II TRS80 equipped with a printer, and it occupies under 4K bytes. It accepts a list of words and then constructs a word puzzle of the type you have, no doubt, seen for sale in newsagents.

I find this program very useful; the puzzles it produces keep my family occupied for hours on end while I am at the keyboard! It is designed to be used by 'non-computer' people, and this is the reason for the emphasis on input error trapping and the 'chatty' style of the prompts.

Many of the statements are special features of the TRS80, notably CLS, which clears the screen, and INKEY$, which is a single keyboard scan and does not need the 'ENTER'. I believe the PET has a similar statement called 'GET'. Only one PEEK is used and this is not essential to program operation anyway, which should please some readers.

The wordsquare and the word list to be used are represented by string arrays S$(n,m) and W$(n) respectively. The program attempts to find vacant areas or matching letters in the array S$(n,m) and put in the words from W$(n). It will try all directions, including backwards and diagonally, and a fair amount of string handling takes place. Not surprisingly, the program can take several minutes to run; in fact it will sometimes appear to 'hang' and won't even respond to the break key. This is due to the fact that the TRS80 has to reorganise its string storage areas occasionally and ignores the keyboard while it is doing this. (This is called Garbage Collection.)

When the puzzle has been constructed it will first be displayed on the screen without the usual jumble of random letters; you can cheat at this point if you wish. The video display section is included for debugging and checking purposes; if you wish to remove it then delete lines 730-800. There is an option for suppressing the usual list of words which are included in the puzzle, which makes it much more difficult, the only clues given in this case being a list of dashes corresponding to word lengths. I have included an example of each option; I am sure readers will find them trivial!

The word list W$(n) is sorted into words of descending length because this reduces execution time by allowing the longest words to be put into a nearly vacant array first, the shorter words then being fitted around and through them.

The randomising methods used ensure that no two puzzles are similar even though they may contain the same words.

**SALTY**

```
F P U Y Y Y O K R V B Z F L L  PERIWINKLE
V P E R I W I N K L E E Y X N  SEASHELL
X E R U M E Q S L E S S U M C  STARFISH
Z C L A M W H S I F R A T S N  SCALLOPS
N S B S L O N E S L I M P E R  ABALONES
K L E H W C S O B R O Z A R U  COCKLES
E Q C H I D C E C O Y S T E R  COWRIES
P C O N C H A A A O L Y L J O  MUSSELS
K T W R H I L F T S C R Z E Y  OYSTER
T R R T Q P L S S J H K A X E  LIMPET
N D I J F K O T X Y X E L E B  RAZOR
V N E H I M P K R X S X L E P  CONCH
S H S C Z N S B Z G S N G L S  WHELK
M S F P S O X C Q L T U A G U  PEARL
W P L M S C B S K L J Y T O Z  MUREX
                              CLAM
```

**BYTE THIS**

```
Z C L O A D Y X L N U W Y N C  ----------
Q T U Y A H D U O A D D G O B  ----------
F I T A R F E X W O N W W I E  ----------
E E W S T A R P M A I G K T N  ----------
Y J E N S W N E T Z F B M U C  ----------
Y A D O T G N I T U P M O C H  ----------
T I N T E G E R B N R Q T E M  ----------
M S O F T W A R E T I X W X A  ----------
I I N T E R R U P T Z R B E R  ----------
G M I C R O S O F T P P P W K  ----------
B H E X A D E C I M A L F K S  ----------
H B L R E N I T U O R B U S D  ----------
M H T I R O G L A Q U U R Q X  ----------
B C K R Y O L S G U B E D Z P  ----------
C P J Q D D R L E D J K K E W  ----------
                              ----------
```

Two specimen "Wordsquares" as produced by the program.

## Variables used

| | | | | | |
|---|---|---|---|---|---|
| A,C,D,G,P,X,I | Counters temporary storage integers. | Q$ | Temporary storage for single letter replies. | S$(n,m) | The string array representing the wordsquare. |
| C(n) | List of shuffled vertical coordinates. | R(n) | List of shuffled horizontal coordinates. | T$ | Title. |
| C1,C2 | Temporary storage for vertical coordinates. | R,R1,R2 | Temporary horizontal coordinates. | W$(n) | List of inputted words. |
| D(n) | List of shuffled directions. | S$ | Temporary storage inputted words. | W1,W2 | Pointers into W$(n). |
| | | | | X1,X2 | Used in row and column shuffle. |

## Program listing

```
10    REM WORDSQUARES
20    REM
30    REM INITIALISE
40    CLS
50    CLEAR 400
60    DEF INT A-Z
70    DIM C(15),R(15),D(8),W$(16),S$(15,15),R2(15),C2(15)
80    PRINT TAB(20)"WORDSQUARES"
90    PRINT TAB(20)"_ _ _ _ _ _ _ _ _ _ YOU WILL NEED A PRINTER
      FOR THIS PROGRAM. TYPE IN A LIST OF UP TO 16 WORDS OR TYPE
      '@' IF YOU WISH TO USE LESS. THE MAXIMUM NUMBER OF LETTERS
      IN A WORD IS 15, BUT IF YOU"
100   PRINT "USE TOO MANY LONG WORDS THE PROGRAM WILL TAKE
      AGES TO RUN. IN FACT IT MAY NOT BE ABLE TO FIT YOUR WORDS IN
      AT ALL! IF SO IT WILL TELL YOU (EVENTUALLY)"
100   REM**SHUFFLE COORDINATES
120   FOR A=1 TO 15:C(A)=A:R(A)=A:IF A<9 THEN D(A)=A
130   NEXT
140   FOR A=1 TO 15
150   R1=RND(15):R2=RND(15):X1=R(R1):X2=C(R2):R(R1)=R(A):
      C(R2)=C(A):R(A)=X1:C(A)=X2
160   NEXT
170   REM**INPUT WORDLIST
180   PRINT"NOW TYPE IN YOUR LIST"
190   FOR W=1 TO 16
200   INPUT S$:IF S$="@" THEN 280
210   IF W=1 THEN CLS:PRINT@2,S$
220   W$(W)=S$
230   REM**TEST THE WORD FOR LENGTH AND CONTENT, S IS ERROR
      FLAG
240   S=0
250   GOSUB 1030
260   IF S=1 THEN 200
270   NEXT
280   W=W-1
290   CLS:PRINT@590,"THIS COULD TAKE ME A FEW MINUTES";
300   REM**SORT WORDS, LONGEST FIRST
310   GOSUB 1190
320   PRINT@590,CHR$(30);
330   REM**CHOOSE THE NEXT WORD
340   FOR W1=1 TO W
350   REM**RANDOMISE DIRECTIONS
360   FOR A=1 TO 8:R=RND(8):X=D(R):D(R)=D(A):D(A)=X:NEXT
370   REM**CHOOSE A COORDINATE
380   FOR R=1 TO 15
390   PRINT@600,"THINKING";
400   FOR C=1 TO 15
410   R1=R(R):C1=C(C)
420   REM**CHOOSE A DIRECTION
430   FOR D=1 TO 8
440   REM**CAN IT BE FITTED?
450   FOR I=1 TO LEN (W$(W1))
460   ON D(D) GOSUB 1090,1100,1110,1120,1140,1150,1160,1170
470   REM**OFF THE EDGE?
480   IF R2>15 OR R2<1 OR C2>12 OR C2<1 THEN 580
490   S$=MID$(W$(S1),I,1)
500   IF S$(R2,C2)<>""AND S$(R2,C2)<>S$ THEN 580
510   R1=R2:C1=C2:R2(I)=R2:C2(I)=C2
520   NEXT I
530   REM**OK WE HAVE A WORDFIT SO PUT IT IN THE ARRAY
540   FOR I=1 TO LEN(W$(W1))
550   S$(R2(I),C+(I))=MID$(W$(W1),I,1)
560   NEXT I
570   GOTO 700
580   NEXT D
590   REM**MUST HAVE FAILED TO FIND FIT SO TRY ELSWHERE
600   PRINT@609,"HARD!";
610   NEXT C
620   PRINT@600,CHR$(30);
630   NEXT R
640   REM**TO GET HERE MUST HAVE FAILED FOR ENTIRE ARRAY
650   CLS:PRINT"SORRY, I CANT COPE WITH ' ";W$(W1);" ', DO YOU
      WANT TO START"
660   PRINT"AGAIN (PRESS 'S') OR PRINT OUT THE PARTLY DONE
      WORDSQUARE ANYWAY (PRESS 'P')"
670   Q$=INKEY$:IF Q$="" " THEN 670
680   IF Q$="S" THEN RUN ELSE CLS:GOTO 730
690   REM**GET THE NEXT WORD
700   NEXT W1
710   REM**PRINT OUT THE ARRAY TO SCREEN
720   PRINT@600,"GOT IT!!!!";CHR$(30);:FOR A=1 TO 800:NEXT:CLS
730   FOR R=1 TO 15
740   PRINT
750   FOR C=1 TO 15
760   IF S$(R,C)=" "THEN PRINT". ";:GOTO 780
770   PRINT S$(R,C);" ";
780   NEXT C,R
790   PRINT"PRESS A KEY";
800   IF INKEY$="" " THEN 800
810   CLS
820   REM**PRINTER STATUS CHECK (OPTIONAL)
830   GOSUB 1260
840   REM**PRINT TO PRINTER
850   PRINT"TYPE IN A TITLE FOR YOUR WORDSQUARE THEN PRESS
      ENTER"
860   PRINT
870   INPUT T$
880   PRINT"BY THE WAY, DO YOU WANT THE WORDLIST PRINTED AS
      WELL? (Y OR N)"
890   Q$=INKEY$:IF Q$="" " THEN 890
900   IF Q$<>"Y" AND Q$<>"N" THEN 890
910   LPRINT TAB(25)T$
920   LPRINT TAB(25)STRING$(LEN(T$),"-"):LPRINT
930   FOR R=1 TO 15
940   FOR C=1 TO 15
950   IF S$(R,C)=" " THEN LPRINT CHR$(RND(26)+64);" ";ELSE LPRINT
      S$(R,C);" ";
960   NEXT C
970   IF Q$="N" THEN LPRINT TAB(48)STRING$(LEN(W$(R)),"-")ELSE
      LPRINT TAB(48)W$(R)
980   LPRINT
990   NEXT R
1000  IF Q$="N" THEN LPRINT TAB(48)STRING$(LEN(W$(R)),"-")ELSE
      LPRINT TAB(48)W$(R)
1010  FOR X=1 TO 4:LPRINT:NEXT:RUN
1020  REM**INPUT TESTING
1030  IF LEN(W$(W))>15 THEN S=1:PRINT"THIS WORD IS TOO LONG, TRY
      AGAIN":RETURN
1040  FO A=1 TO LEN(W$(W))
1050  S$=MID$(W$(W),A,1)
1060  IF S$<"A" OR S$>"Z" THEN S=1:PRINT"LETTERS ONLY
      PLEASE.":RETURN
1070  RETURN
1080  REM**HORIZONTALS AND VERTICALS
1090  R2=R1+1:RETURN
1100  R2=R1-1:RETURN
1110  C2=C1+1:RETURN
1120  C2=C1-1:RETURN
1130  REM**NOW THE DIAGONALS
1140  R2=R1+1:C2=C1+1:RETURN
1150  R2=R1+1:C2=C1-1:RETURN
1160  R2=R1-1:C2=C2+1:RETURN
1170  R2=R1-1:C2=C2-1:RETURN
1180  REM**WORDLENGTH SORT
1190  S=0
1200  FOR W1=1 TO W-1
1210  IF LEN (W$(W1))<LEN(W$(W1+1))THEN S$=W$(W1):W$(W1)=
      W$(W1+1): W$(W1+1)=S$:S=1
1220  NEXT
1230  IF S=1 THEN 1190
1240  RETURN
1250  REM**PRINTER CHECK TO PREVENT SYSTEM HANG
1260  IF PEEK(14312)<=127 THEN RETURN
1270  PRINT"PRINTER NOT READY!! PRESS 'P' WHEN THE PRINTER IS
      READY OR 'S' TO START AGAIN"
1280  Q$=INKEY$:IF Q$="" " THEN 1280
1290  IF Q$="S" THEN RUN
1300  IF PEEK(14312)<=127 THEN 1270
1310  IF Q$="P" THEN CLS:RETURN
1320  GOTO 1280
```

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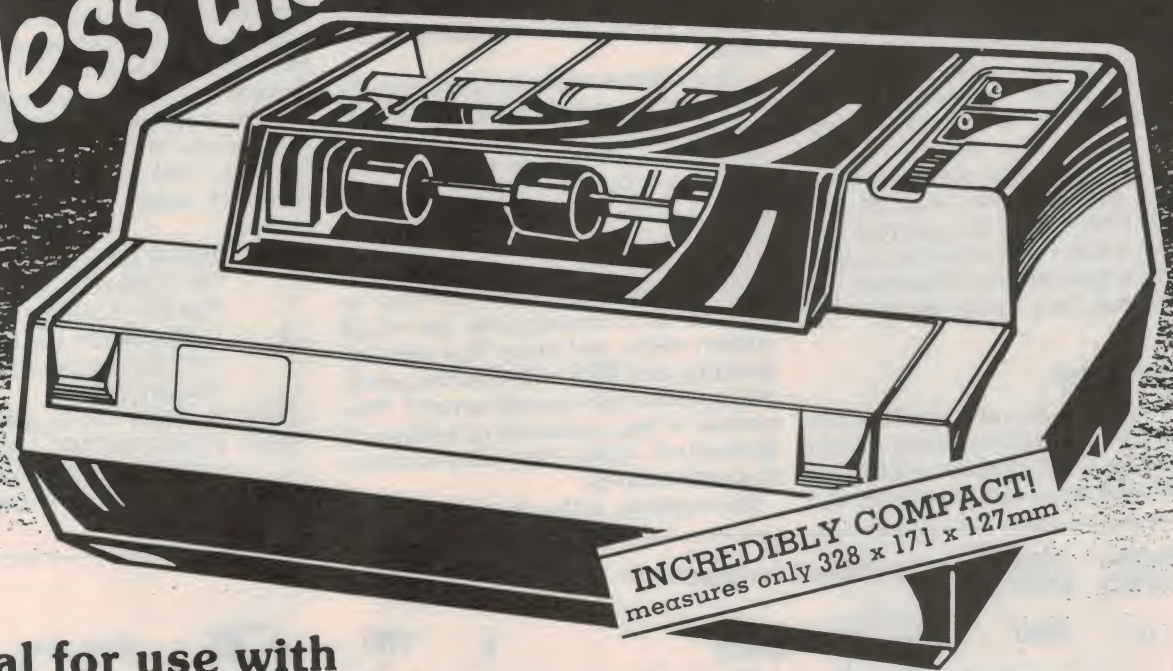


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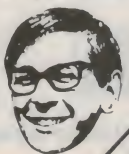

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# PET Talk — double density

**Paul Williams**

Double the plotting capacity of PET with this routine.

THE FOLLOWING simple program listing allows plotting of characters on an 80 by 50 grid on the PET screen, thus enabling more precise graphs and pictures to be drawn. The first two lines of the program (lines 1 and 2) should be included at the beginning of the program that is to use the double-density feature; they initialise the two arrays required. The plotting section (the last two lines) can be called by a GOSUB 1000 during the program run, after an x and y value has been specified. The x value should be between −39 and 39, and the y value between −24 and 24.

## Where to go

Assigning 0 to both x and y will produce a dot in the centre of the screen: −39 for x and 24 for y will produce a dot in the top left-hand position of the screen, and 39 for x and −24 for y will be in the bottom right-hand corner of the screen. Thus the positions radiate as for a normal graph from the centre of the screen.

The program works by arranging the codes for the sixteen different double-density graphics in such a way that if the position of the code already on the screen is ORed in binary with the position in the array of the code that you want to put on the screen, the resulting position will give the code containing both the characters that you want to plot. Array S contains the list of all sixteen codes, and array T is used for decoding the PEEK code from the screen into a position for use with array S. This method is best explained by looking at the array S. Table 1 shows the contents in graphical form.

For example, if the character ▗ was on the screen, and the character ▖ wanted to be added, the position of the first character, 0 0 0 1, is ORed with the position of the second character, 0 1 1 0; the result obtained is 0 1 1 1, which, in the table, is the character ▟, which is the one required to POKE on to the screen. Line 1010 of the subroutine does this, as well as calculating which character needs to be added to the screen.

```
1    DIM S(15),T(255):FOR T=0
     TO15:READ S(T):
     T(S(T))=T:NEXT T:T=0
2    DATA 32,123,126,97,108,98,
     127,252,124,255,226,236,225,
     254,251,160
1000 S=33267+(X/2)-INT(Y/2)*40
1010 POKE S,S(T(PEEK(S)) OR
     (2▲((X/2-INT(X/2))*4+
     ((Y/2-INT(Y/2))*2)▲2))):
     RETURN
```

| POSITION IN ARRAY | BINARY POSITION | DECODED CHARACTER | | POSITION IN ARRAY | BINARY POSITION | DECODED CHARACTER | |
|---|---|---|---|---|---|---|---|
| 0 | 0000 |  | SPACE | 8 | 1000 |  | SHIFTED < |
| 1 | 0001 |  | SHIFTED ; | 9 | 1001 |  | RVS SHIFTED ? |
| 2 | 0010 |  | SHIFTED > | 10 | 1010 |  | RVS SHIFTED " |
| 3 | 0011 |  | SHIFTED ! | 11 | 1011 |  | RVS SHIFTED , |
| 4 | 0100 |  | SHIFTED , | 12 | 1100 |  | RVS SHIFTED ! |
| 5 | 0101 |  | SHIFTED " | 13 | 1101 |  | RVS SHIFTED > |
| 6 | 0110 |  | SHIFTED ? | 14 | 1110 |  | RVS SHIFTED ; |
| 7 | 0111 |  | RVS SHIFTED < | 15 | 1111 |  | RVS SPACE . |



Table 1. The block graphics characters and their binary and character key designations for producing the double density effect.

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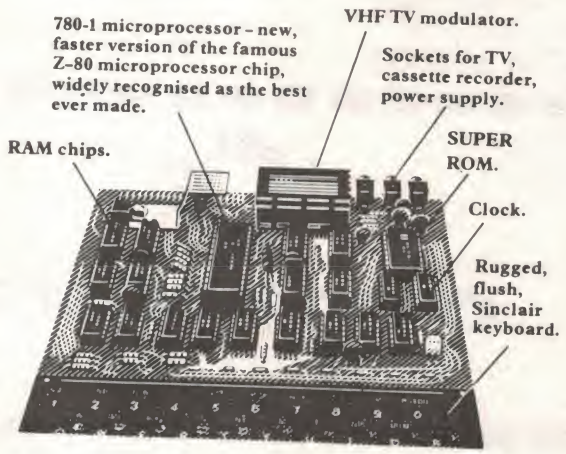


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# More POKEing on your ZX80

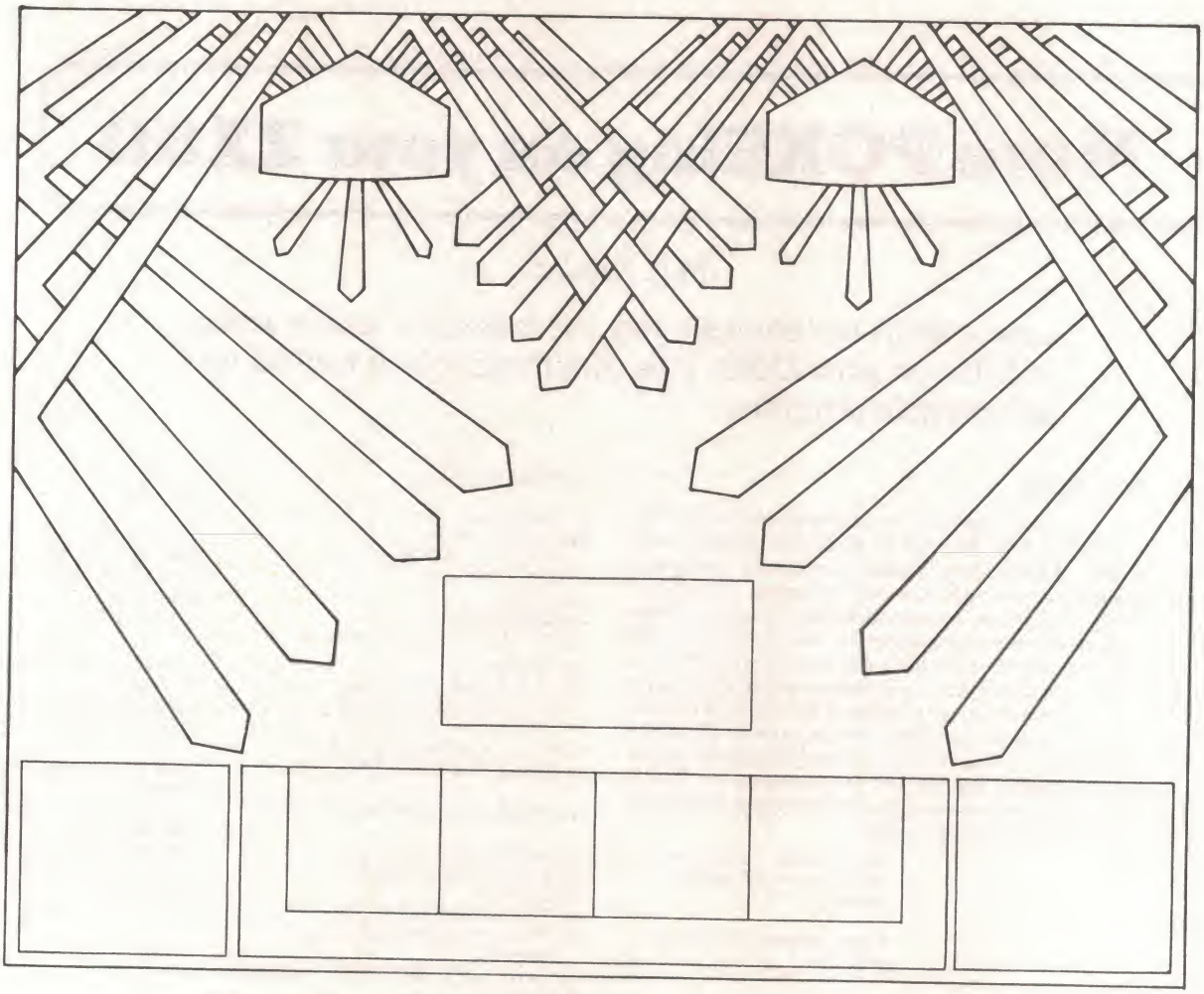
**M.E. Bryant**

Last month we showed you the basics of using screen POKEs on your ZX80. This month we round it all off with an example program.

## Graphic Example

Just for fun, here is a simple program that demonstrates the features discussed in the last article. It just fits in the 1K ZX80. The computer prints up a display consisting of black and grey squares in a pattern determined by a number input at the beginning of each series of games. The object of the game is to get the "woodworm" (an asterisk), which first appears at line 8 column 1, to eat its way across the screen to column 32 in the least number of moves. The snag is that the black squares represent a particularly tough kind of wood and each time one is eaten a penalty of 5 moves is incurred. Numerals 6, 7 or 8 are input as pseudo-cursor controls to move the insect down, up, or forwards respectively. The computer keeps track of the number of moves taken to reach column 32 and displays the total at the end of each game together with the best performance in the present series. Pressing NEWLINE after a game sets up another game in the same series. Entering a character starts a new series.

```
 2 LET Y = 32000                    No. of moves — best so far!
 4 INPUT R                          Seed for random number
                                    generator
 8 LET P = 0                        Assign variables prior to PEEK
10 LET W = 0                        and POKE
12 LET B = 1
14 LET A = 8
16 LET Z = -1
18 LET M = 0
20 RANDOMISE R                      Set seed for random number
                                    generator
22 FOR N = 1 TO 352
24 LET D = 9
26 LET X = RND(2)
28 IF X = 1 THEN LET D = 128        Print eleven lines with black and
30 PRINT CHR$(D);                   grey squares at random. Pattern
                                    determined by R.
32 NEXT N
34 GOSUB 500                        Locate display-file
36 POKE W + 232, 20                 Insect in initial position
38 LET Z = Z + 1                    Count No. of moves
40 INPUT C                          Which way?
42 GOSUB 500                        Locate display-file
44 LET M = W + (A - 1)*33 + B
46 POKE M, 0                        Put a space where insect is
48 IF C = 6 AND A<11 OR C = 7 AND   Set A and
   A>1 THEN LET A=A-2*C+13          way and make sure we don't
                                    POKE off-screen
50 IF C = 8 THEN LET B = B+1
52 LET M = W + (A-1)*33 + B         Set M to next insect location
                                    address
54 IF PEEK(M) = 128 THEN LET Z=Z+5  If there's a black square in the
                                    way, add penalty
56 POKE M, 20                       Put insect in next location
58 IF B = 32 THEN GOTO 62           Watch for end of game
60 GOTO 38                          Next move
62 IF Z<Y THEN LET Y = Z            Set Y to best so far
64 PRINT "END OF GAME IN ";Z;"
   MOVES"
66 PRINT "BEST SO FAR ";Y;" MOVES"
68 INPUT X$
70 CLS
72 IF X$ = " " THEN GOTO 8          NEWLINE for another game
74 RUN                              Any character for another series
500 LET P = PEEK(16397)             Subroutine for setting W to
510 IF P>127 THEN LET P = P-256     address of start of display-file
520 LET W = PEEK(16396) + P*256
530 RETURN
```



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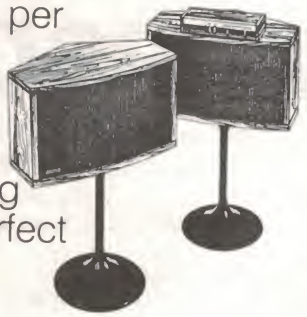

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# Sight & sound

# Software's the key in the videodisc war

Philips might have the best system technically, Japan's VHD is moving fast and has a lot of oriental clout behind it, and RCA's Selectavision is at present the cheapest, but in the end it's the videodisc system that can provide the movies the public wants — and lots of them — that will win out in the market.

**MARCH 1981 officially saw the videodisc war get under way.**

Philips' laser-optical players have been test-marketed in the US for the last eighteen months or so, under the names of both Pioneer and Magnavox, but for reasons we'll explore later haven't swept the market despite this staggering time advantage. The other two systems promised as contenders in the videodisc war seemed at times as if they'd never get off the ground, but finally things are hotting up.

RCA (an American system) launched its Selectavision system on March 23 with an advertising and promotion budget of US$15 million. It will sell for US$499 and has a library of videodiscs priced at between US$14 and US$27. This library falls short by 50 of the promised 150 titles, but RCA says it will introduce another 25 in May and 25 in August.

Meanwhile the JVC-developed VHD (Video High Density) system from Japan is also a reality following the opening of a videodisc manufacturing plant in Los Angeles in March.

## RCA's Selectavision

The RCA player is priced at around US$200 cheaper than the optical players from Magnavox and Pioneer, but lacks many of the facilities that their laser system offers. The Philips/Pioneer/Magnavox players have freeze frame, random search system, stereo sound, frame-by-frame advance, numbered frames, a laser beam for a stylus and a disc that will never wear out. In contrast the Selectavision system has only mono sound, straight play, and uses a $70 stylus that sits in a groove similar to a standard audio record; both it and the discs will wear out.

However, RCA's system is by far the cheapest, as well as being scheduled to have 200 000 players into the US market by the end of twelve months, so both Philips and VHD have been forced to buck up their ideas if they aren't to be elbowed out of the market.

## Japan's VHD system

There is to all intents and purposes only one video system in Japan, the reason being that the Japanese government 'suggested' that all Japanese manufacturers get behind one system — for obvious reasons. Pioneer has even been criticised on the government TV station NHK and in the press for not joining this 'Japan Club', but by now has too many millions tied up in the optical system to change sides now. Besides, it sees the optical system as the best and plans to support it to the end.

The VHD groundswell was quite a surprise to the industry, but it was obviously provoked by Philips' slowness in getting its system going as well as it should and by Selectavision's relative shortcomings. Matsushita announced about a year ago that it planned to back this third system, developed by its subsidiary JVC, and sure enough at the 1980 Tokyo Electronics Show not only Matsushita but nearly every major Japanese manufacturer was showing prototypes of the VHD videodisc, Pioneer and Sony being the only notable exceptions.

The Japan Club is slightly less solid on the more controversial international scene, however; Toshiba and Sanyo were proposing to make optical players for Europe, RCA Selectavision players for the US, as well as VHD players for the home market. Hedging their bets?

The VHD club, consisting of Matsushita (National Panasonic), JVC, General Electric and Thorn/EMI, plans to press discs for the movie companies and let them market the product themselves. This will save the electronics companies millions in royalties and will also assure the movie companies of maximum profits from the movie rights — which may well make them more willing to release movies for videodisc. The discs will be distributed by the movie companies in the same way as record companies distribute their own audio discs.

**Blockbuster movies — like The Wild Geese, starring Richard Burton (scene above) — on software will sell videodisc systems.**

The VHD Manufacturing Co., just opened in Los Angeles, will press the discs for the movie companies for between US$5.50 and US$6.50 each, with a minimum production run of 3000. According to Gary Dartall, who heads both VHD Programs and VHD Disc Manufacturing, approximately 200 titles will be available in substantial quantities when the VHD player hits the US later this year.

The VHD system falls about midway between Philips and RCA in the features it offers, having a random access search system with an add-on component, and not actually touching the record so there's no surface wear.

## Philips' laser system

The laser videodisc system developed by Philips is in the third corner of the video war ring. In fact they've been out there sparring for a while now, but it wasn't till the competition made serious moves that they seemed to realise the war was on in earnest.

Panicked by RCA's cheapness and the sudden groundswell towards Japan's VHD system, Pioneer and Philips have finally started a true push into the US market. Pioneer started shipping in big lots last October and plans to have placed over 100 000 machines into the US market by October this year. Philips' US subsidiary Magnavox has also increased production and by October should have 60% of the US market covered, geographically speaking. So Philips may still have a chance to head off both VHD and RCA — as long as they get their software — i.e: disc — problems sorted out.

Philips has negotiated to buy Sylvania and Philco, which are leading TV manufacturers. If successful, it will give Philips 10% of the TV market in the US and a formidable back-up to its optical videodisc marketing plans.

Meanwhile, back in Europe Philips is making sure that the optical disc player is the chosen PAL standard. It has built a hardware factory in Belgium to produce players and a software factory in the UK to make the discs using an as yet ▶

undisclosed photographic process.

The Philips videodisc will be launched in the UK this year on a test market basis, and since it is the first PAL videodisc system it is of vital interest to Australia. We will inevitably source our software from the UK because we have the PAL TV system, while Japan and America have the NTSC colour system.

So the battleground is drawn up. RCA offers a cheap and cheerful player, Pioneer and Philips a sophisticated laser system they argue is the only way to go in the future, and VHD has its system which is a cross between the two. Since the ultimate winner will be the one which offers not superb technical performance nor a cheap price, but rather the largest selection of good, up-to-date, popular movies, it has to be the software which decides the outcome of the war.

### The disc situation

Lack of software — discs — lies behind Philips not having swept the videodisc market despite having over a year's lead on the Selectavision and VHD systems.

When MCA Universal and Pioneer Electronics got together a few years ago it looked like the perfect marriage. Pioneer's job was to refine the laser disc player originally developed by Philips, while MCA, which has around a 50% share of the US entertainment scene, was to develop the software and provide the library — a European system, with hardware built by a Japanese company and software manufactured and provided by an American company.

Towards the end of 1979 it became obvious that all wasn't rosy. With Philips not taking an active part in the software side of the business, MCA was not producing enough titles or solving production problems of the optical videodisc. Both RCA and Matsushita executives cite these disc problems as the reason for their going ahead with their rival systems. MCA sold 50% of its share in the Universal Pioneer company, without explanation, to IBM. This gave Pioneer 50%, MCA Universal 25%, and IBM 25%.

Pioneer and Philips, impatient with the snail-like pace MCA was proceeding at with the software, formed their own company called Optical Programme Associates (with MCA Universal and IBM) to actively pursue the necessary software for the laser system. Pioneer has also built a disc factory in Japan.

While the new 'photographic process' by which optical system discs are made hasn't yet been revealed by Pioneer or Philips, it's obviously a very different and newer process than that for both RCA and VHD discs, which can be pressed in a factory in a similar fashion to audio discs. However, both these rival discs have to be handled very carefully. The disc in both systems comes in a 'caddie' (like a record sleeve). The caddie with the disc inside it is pushed through a slot in the front of the player, then the disc settled into the player and the caddie removed from the slot. The reverse procedure has to be gone through to remove the disc. It must therefore be practically untouched by hand, whereas the laser system disc can be thrown across the room and jumped on without damaging it.

However, even if Pioneer's new factory and Philips' new photographic process have finally ironed out problems in disc production, it'll all be academic if they can't come up with good movies and up-to-date pop concerts to go on them. MCA Universal has a vast library of movies, but for some reason hasn't been making them readily available on laser discs; there are only 200 titles available in this system after 18 months in the marketplace.

The industry calls this the 'soft software' problem, but basically they mean movies. It's movies that will sell a system; no matter how good technically or how cheap a system may be, if the public can't get the range of movies and entertainment they want to go with it, they won't be buying that system.

### What about Australia?

There is one sane thought for Australians in this complex international punch-up. The various manufacturers are going to be so busy fighting each other in the lucrative US and Japanese markets that they probably won't give us a thought.

The odds are that Philips will establish a PAL optical system in Europe and that is what we will eventually get. By the time they get round to launching it here, either late this year or early 1982, the market patterns elsewhere will probably be established — and there will already be a good supply of movies available! The only threat to Philips on the PAL front is EMI-Thorn, who are backing the VHD system.

Pioneer has started the ball rolling in Australia by selling 300 players to GMH dealers around the country, an idea based on the American General Motors deal in which Pioneer Electronics supplied some 13 000 industrial videodisc players to dealers around the US for promotion of new car models and staff training. (See box on page 133.)

There's more to this than just expanding the videodisc market into business. Managing Director of Pioneer Electronics Australia, Les Black, says that selling 300 videodisc players has subsidised the cost of setting up a service department for videodisc players in readiness for their launch in Australia. Not bad?

But don't get too excited. He also says that he has to give Japan six months' notice for stock in the PAL format — and he won't do this until he is sure there will be software to support it.

So, unless EMI-Thorn get their PAL system off the ground in time to be serious competitors, it looks as if it's all eyes on Philips in Europe for the videodisc system that will take over the market in Australia — though we might have to wait a while yet to see it happen.

**Dennis Lingane**

## Fast videotape copier

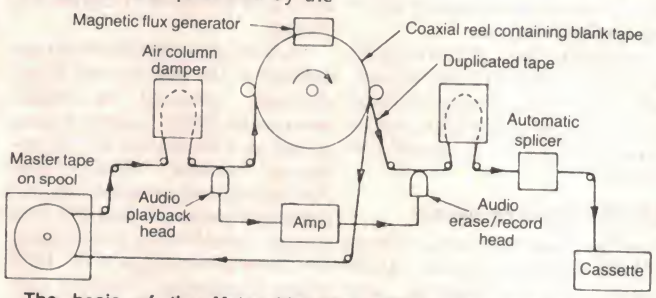
**In the past, duplication of video tapes has had to be carried out in real time, so that a two-hour tape would take two hours to duplicate. This is one reason why there is such great interest in videodiscs, which can be produced easily in large numbers.**

The helical scanning format used in video tape systems prevents high speed copying, as is done with audio tape duplication. However, Matsushita have now demonstrated a prototype high speed VHS copier which can duplicate a three-hour tape in just three minutes.

The essentials of the Matsushita system are shown in the diagram. The high coercivity master tape is wound in close contact with the blank tape and both are exposed to a magnetic field produced by the magnetic flux generator. The method of duplication is based on the bifilar printing system for the video signal, the master tape's image being copied on to the blank tape.

However, the audio signal is transferred quite separately to the blank tape in order to achieve maximum audio quality. The whole machine has been designed for automatic operation.

**Brian Dance**




**The basis of the Matsushita fast bifilar video tape duplicator.**

## Hitachi metal

**Hitachi are currently introducing metal tapes in two new lengths as their ME46 (46 minutes' recording time) and as their ME60 (60 minutes' recording time).**

The pure metallic particles in these tapes have been treated by a special process which coats each particle with a special anti-oxidant so as to produce greatly increased particle stability.

It is claimed that the use of these tapes enables the maximum output level to be increased by 2 dB at the lower and mid-frequency ranges when compared with high quality chromium dioxide tapes. In the upper frequency range the maximum output level is 8 dB higher than that obtainable with chromium dioxide tapes, Hitachi say.

**Brian Dance**

## Hitachi's latest VHS Recorder

**Following the introduction of their VT 8000 VHS video recorder, Hitachi are now adding the VT 8500 to their range; this incorporates a sophisticated microprocessor in its circuitry.**

The microprocessor enables five programmes to be recorded over a seven-day period either on the same or different channels. The principle controls are touch operated using integrated circuit logic either directly or by means of an infrared control key pad which enables no less than twelve different modes to be selected from the comfort of one's armchair.

The available modes include double speed playback, slow motion playback, freeze and advance frame, rewind/fast forward, play, record, change channel and a facility which enables the user to locate quickly any section of the tape by speeding up the playback to five times the normal speed.

Hitachi have included a test signal generator in the VT 8500 which enables the video channel of the television receiver to be accurately tuned in by using the black and white test pattern instead of having to play back a pre-recorded tape. In order to avoid damage to video tapes from moisture accumulating during wide temperature changes, a dew detector circuit has been incorporated into the recorder, which detects the presence of moisture on the tape head and switches on a flashing warning LED indicator — apart from disabling the recorder until the condensation has evaporated.

A timer back-up circuit is incorporated into the VT 8500 so that if the power should fail for a short time, the instructions coded into the memory of the equipment will not be lost from the memory. In the record mode, users cannot accidentally switch the recorder over to a different channel whilst another channel is being watched, since an automatic channel-locking circuit is employed to prevent this.

The VT 8500 is similar in style to the VT 8000, but is one of the lightest mains-powered units on the market, with a weight of about 12 kg.

**Brian Dance**

## New series TDK reel-to-reel tapes

**In response to demands by professional, semi-professional, and home open-reel tape recordists for higher quality tape products, TDK (Australia) Pty Ltd have introduced two new lines of quarter-inch (6.25 mm) open reel audio tapes.**

Designated TDK GX Studio Mastering Series and TDK LX Professional Studio Series, both lines represent significant breakthroughs in open reel magnetic tape technology, TDK say.

The GX series is designed specifically for studio master use in live music mastering, and is, according to the corporation, the finest quarter-inch open reel tape on the market.

The LX series is designed for use in professional broadcast recordings and for semi-professionals seeking higher quality performance from an open reel tape to meet demanding recording applications.

The GX series features TDK's newly developed ultra-fine gamma ferric oxide particle tape formulation with extremely high output and low distortion throughout an extended range.

TDK claim the GX Studio Mastering Series has a maximum output level (MOL) of +14 dB (measured at 400 Hz), low frequency sensitivity of +1.5 dB at 400 Hz, mid-frequency sensitivity of +2 dB at 3 kHz, high frequency sensitivity of +6 dB at 20 kHz, bias noise level of −57 dB and tape distortion level of 1.3%.

The LX series is available in lengths from 1200 ft to 3600 ft and in running times from 60 to 180 minutes (at 19 cm/sec.) and in newly designed super precision 10" metal reels and 7" plastic reels. The reels each consist of a separately moulded hub and flange to ensure perfect circularity and high strength.

Of the GX series, only the 1800 ft length, 90 minute running time, is available in Australia at this stage. The GX and LX series supersede the old series S, L, and LB which are no longer available. Both lines feature a dust-proof cleaning leader tape with a timing cue. Recommended retail prices for the GX and LX series are: LX 35 90 $12.30, LX 35 180M $34.49, LX 35 90B $13.52, LX 35 180BM $38.16, LX 50 60B $12.30, LX 50 120BM $34.49, GX 35 90B $18.29.


## Sanyo announces new Beta video cassette recorders

**Sanyo Australia recently announced two new Beta format products to complement the continuing success of their VTC9300PN video cassette recorder.**

First will be the Sanyo VTC 3000P portable video cassette recorder, which was launched on the Australian market in March this year.

The portable VCR will be followed in June by the release of Sanyo's second-generation Beta format VCR, featuring microprocessor system and infrared remote control.

Introduction of these new products consolidates Sanyo Australia's long-term commitment to the Beta format in video tape equipment, and the enlarged video product range is designed to cater for all popular price points demanded by the Australian market.

On the world scene Sanyo Japan recently announced plans to manufacture VHS format VCRs in addition to the well-established Beta system. This move is designed to increase Sanyo's VCR market share in America, the UK and Europe.

With the recent decision to manufacture RCA, VHD and Philips videodisc systems, Sanyo aims to become the world's leading supplier of domestic video equipment. Sanyo already supplies one-third of the world's tape recorders and claims to be the leading supplier of microwave ovens.

For further information please contact Mike Hart, Australian Sales Manager, Sanyo Australia Pty Ltd, 225 Miller Street, North Sydney NSW 2060. (02)436-1122.

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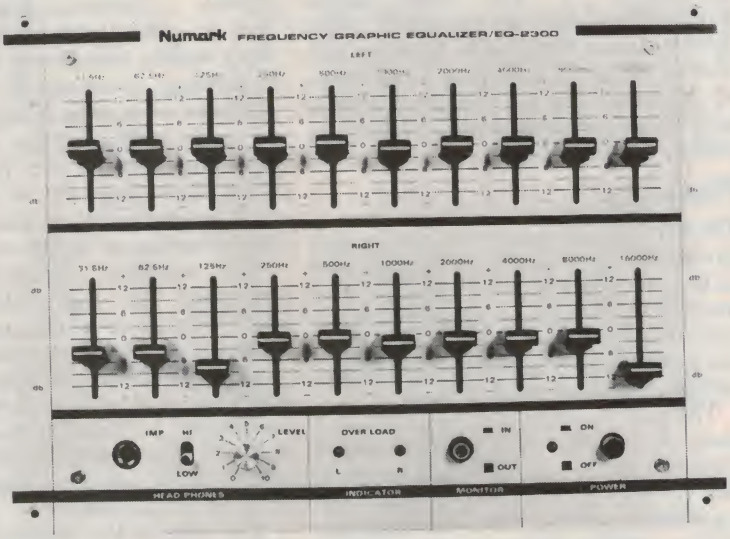


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# Sony TA-F80 amplifier — superb technical performance and quality sound

Louis Challis didn't care much for the look of the Sony TA-F80 amplifier, but in every other way he has nothing but praise for it.

**Louis A Challis**

THE SONY TA-F80 pulse-locked power supply integrated stereo amplifier is an example of a new breed of amplifier which exhibits features and performance which the average user has heard about in technical articles but not yet seen presented as a commercial article. The unit we received for reviewing is one of the first examples of this amplifier to hit the Australian market, but by the time this review comes to print you will most probably be able to purchase one in your local hi-fi shop or showroom.

In Japan this type of amplifier is readily available and has already achieved an excellent degree of acceptance; if you read Dennis Lingane's report on the 1980 Tokyo International Electronics Show in ETI, March '81, you'll understand why this is so. However, it's not just the Japanese passion for gimmickry that will be satisfied by this amplifier.

## Features

The first thing you notice when you pick this amplifier up is that it weighs about half as much as any comparably rated amplifier. This is the result of an entirely different approach to the design of the power supply and also the heatsink used for the power output stage.

The power supply is novel in that it uses a 20 kHz pulse-locked circuit incorporated in a neat diecast screened can. It uses a different rectification and regulation system from conventional power supplies, achieved by rectifying the ac at the input to produce a nominal dc voltage. This dc voltage is then converted to a 20 kHz square wave, which is controlled by a feedback circuit in order to achieve correct load regulation.

The output of the unit is rectified again and filtered by two pairs of chokes and two pairs of capacitors to produce a positive and negative voltage at 51 volts.

Because of the very high frequency involved, there are no audible components produced and, more importantly, the filter capacitors are so small that isolation between the two channels is primarily designed for crosstalk requirements.

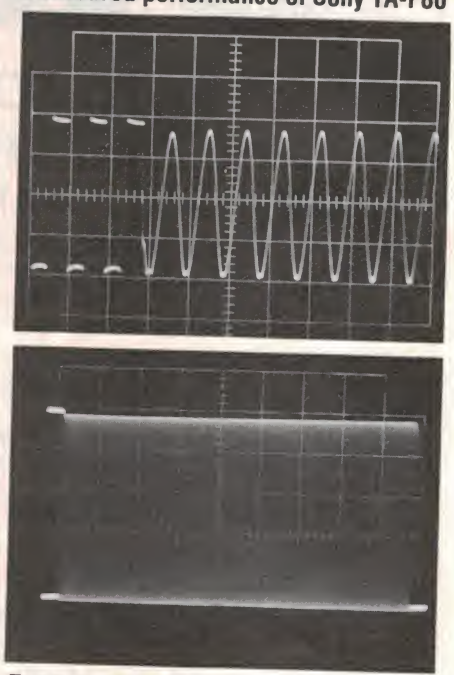
Not content with this, the Japanese designers have designed an output stage based on the use of a liquid/vapour phase heatsink radiator system. This is unusually light compared with the normal aluminium-finned heatsink, and it offers remarkable efficiency. Sony admits that this is a NASA space technology development, and say that its major advantage is the enhancement of power output stage cooling. They have incorporated very high frequency transistors (high-$F_t$) to reduce intermodulation distortion and provide what they describe as 'crisper sound'.

The external appearance of the amplifier is regrettably not as attractive as one would expect from the technical features incorporated within. Unlike other Sony products, which have achieved a standard of neatness and associated attractiveness acknowledged by most people in the trade and by the public, this amplifier looks much more 1970 than 1980.

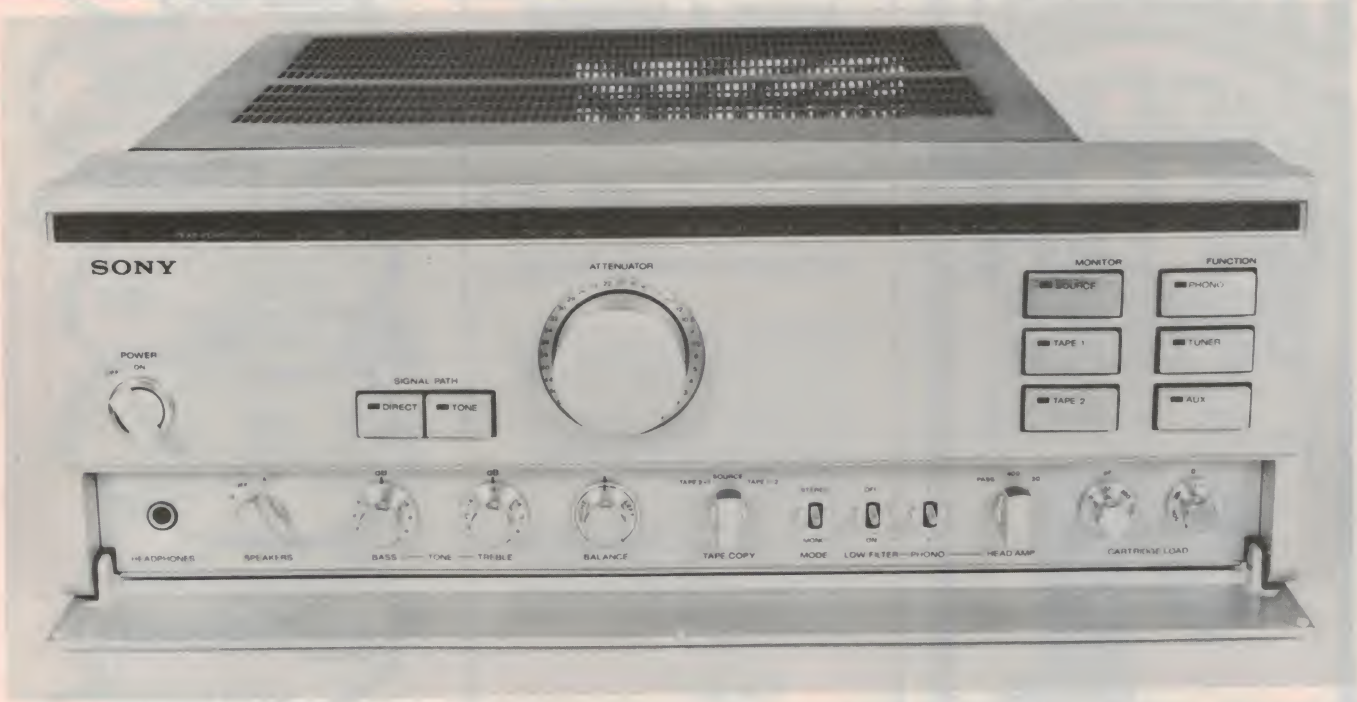
The front of the amplifier features a recessed bezel right across the top with a red plastic insert. Behind this are located two arrays with 20 light-emitting diodes in each array. These indicate the peak power into eight ohms and are accompanied by engraving on the plastic bezel of nine sets of power indications ranging between .01 and 130 watts. The bottom light in each array is continually illuminated and indicates that the power is on.

Underneath the bezel on the left is a rotary knob for turning the power on and off. There is a 4-second delay before the amplifier actually switches itself on, during which time the pulse-locked power supply comes into operation and

**Measured performance of Sony TA-F80**



Transient overload recovery test (IHF-A-202)
1 ms/div.
50 ms/div.
10 dB overload re rated power into 8 ohms — both channels driven. Overload duration: 20 ms; repetition rate: 512 ms.




charges up the filter capacitors.

In the middle of the escutcheon is a large attenuator calibrated in dB re maximum output with typical 1 dB steps to −6 dB, 1.5 steps to −18 dB, 2 dB steps to −40 dB and 10 dB steps from −50 to −70 dB.

To the left of this volume control are two switches which allow the signal path to be switched direct or through the tone controls; each of these switches is illuminated by means of a LED inset into its face, which indicates which path has been selected.

On the extreme right hand side are six switches, also incorporating LEDs, three indicating what is being monitored (source, tape 1 or tape 2) and three for function (phono, tuner and auxiliary).

All along the bottom of the escutcheon is a hinged flap which is normally closed, behind which are the minor controls including a headphone socket and a speaker selector socket for A, B and off. I like this feature, as it helps to provide an uncluttered front panel appearance.

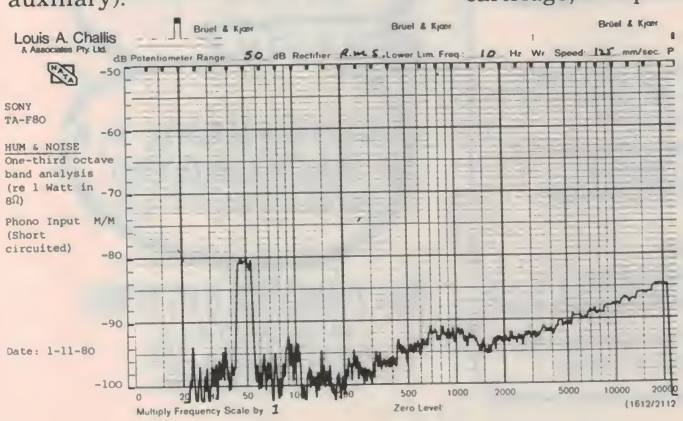
Behind this flap on the right are bass and treble tone controls, a balance control with a sensible central indent, a tape-copying function switch with positions of source, tape 2 to tape 1, and tape 1 to tape 2. To the right of these controls toggle switches are provided for stereo/mono, low filter on and off, phono 1 or phono 2.

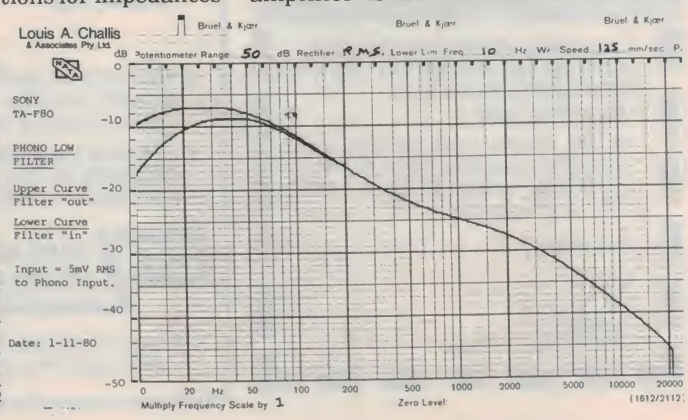
The next control is a rotary switch to activate the head amp for moving coil cartridge, with positions for impedances of three ohms, 40 ohms and a pass position if it is not required. The final two switches provide the cartridge loading facilities, with switch-selectable input capacitors of 100, 130, 200, 300 and 400 pF and input impedances of 100k, 50k, 20k and 100 ohms.

The rear of the amplifier is rather different from other units in that the rear panel only features four pairs of screw-up terminals for two sets of speakers, and one switched and two unswitched ac outlets for parallel-pin mains plugs. (This feature will obviously be deleted from the normal units designed for the Australian market).

## Inside the amp

The main electronic section of the amplifier is not as wide as the front ▶

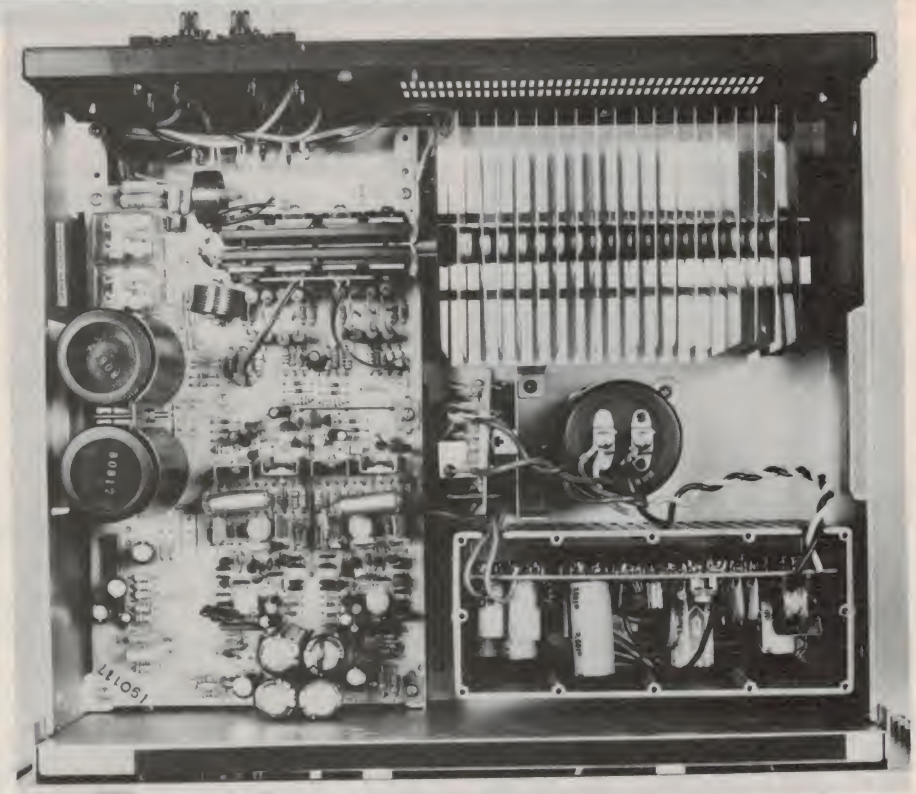


panel and consequently an edge of the front panel extends out to the right hand side. This provides a convenient access point for making direct connections into the preamplifier stage.

The connections for all low-level signals are provided at the rear of this section by a series of coaxial sockets. The phono sockets are gold-plated and the designations for circuit connections are sensibly screen-printed on the side of the adjacent painted steel cover.

The inside of the amplifier is extremely neat, the most outstanding features being the 'pulse-locked power supply' and the liquid/vapour phase cooling heatsink. One thing very clearly noticeable is the logical layout, which minimises unnecessary wiring and 'crossed wiring' paths. One other feature is the neat circuitry and chokes in the output stage feedback path, directly connected to the unusual output power stages, and a fast relay switching system to prevent you from destroying those stages.



**Internal view of the TA-F80. The power amplifier board runs along the left hand side, with the power output devices at the rear. The vapour-phase heat pipe and heatsink runs from the output devices to the right. The switchmode power supply is in the compartment at right front (lid off). The preamp is in its own shielded compartment at the front (not visible).**

## On test

The objective testing of the amplifier proved how outstandingly good this unit is. The frequency response with the tone controls disconnected extends from 1 Hz to beyond 100 kHz with an absolute flatness of better than +/−1 dB. With the tone controls centred and activated the frequency response is still 8 Hz to beyond 100 kHz.

The sensitivities for the moving magnet cartridge input are 250 microvolts with a 350 millivolt overload point, whilst for the moving coil cartridge input they are 12 microvolts with 17 millivolts overload point. The harmonic distortion is less than .007% at 120 W output at all frequencies and still less than .008% at the 1 W level.

The transient intermodulation distortion is very much less than 0.05%, whilst the hum and noise levels are −81 dB(A) for the auxiliary, −80 dB(A) for the moving magnet input and −78 dB(A) relative to the moving coil cartridge input, with the volume control set for 1 W output. The transient overload recovery test shows an excellent but not perfect recovery response from overload clipping.

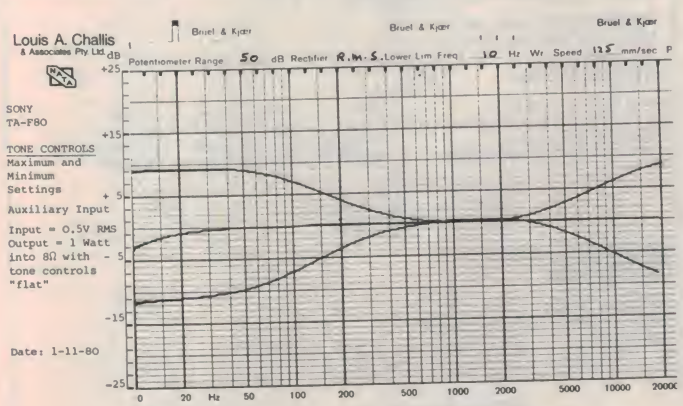
The tone controls offer a reasonable +/−9 dB boost and cut at 50 Hz and +/−9 dB boost and cut at 20 kHz.

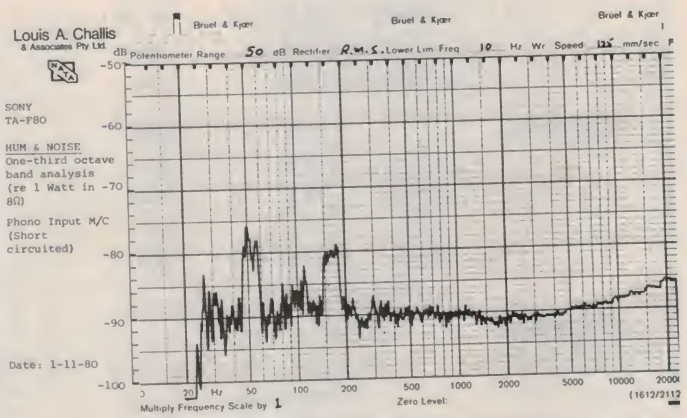
The phono 'low filter' response can only be exhibited through the phono input and from this it can be seen that 7 dB of cut is provided at 10 Hz as a means of reducing wow components from being amplified in the main amplifier, should this prove to be a problem.

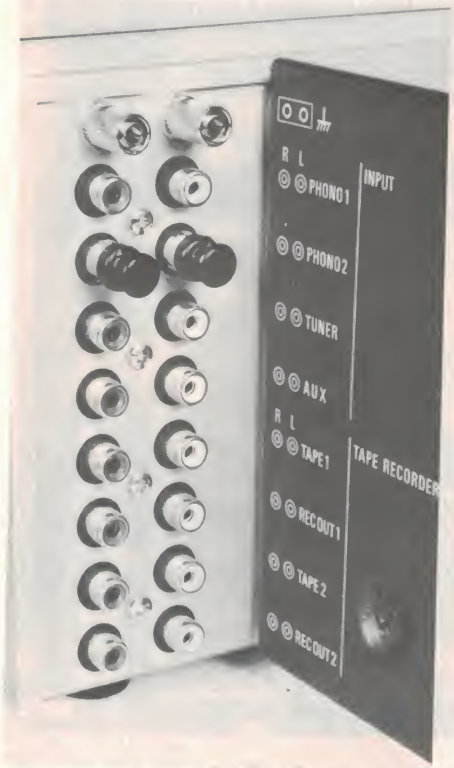
All in all the measured performance equals or exceeds the manufacturer's stated figures by a fair margin; the distortion figures are particularly good.

## In use

In practical usage this amplifier is no slouch. I used it at home to play classical music in conjunction with a series of other record players and cassette players that we have recently reviewed, ▶






**The input terminals are behind the front panel and go direct to the preamp pc board with minimum lead length.**

and found its performance superlative, particularly with moving coil cartridges and no less with moving magnet cartridges.

The impedance and capacitance adjustment capabilities make it possible to trim the frequency linearity of each respective cartridge to achieve a flatter response than would be normally obtainable without protracted and messy adjustments at the input terminals. This feature alone places it in keeping with some of the more expensive and esoteric amplifiers which I have reviewed over the last year (although, I must admit, this is already an esoteric amplifier).

I played many new records both conventional and direct to disc, many of them from Sony/CBS in Japan, and they provided a degree of brilliance and natural fidelity which (with the best loudspeakers) was breathtaking. This amplifier was the main one I used in my evaluation of the B & W 801 series speakers (see ETI, Feb. 1981), and it helped to provide some of the purest and sweetest sound imaginable.

Because of the power to weight ratio of this amplifier we took it into the field to provide high-powered test signals in a number of unusual locations. With continuous outputs of 125 W and with tone-burst testing to detect flutter echoes in auditoria, the amplifier proved that it not only has good performance, but can maintain that performance for extended periods of time even with nasty signals that would be expected to destroy its output stages and thoroughly test its protection circuitry.

I don't particularly like the appearance of the Sony TA-F80 amplifier, but I must admit I have more than just a bedgrudging respect for its technical panache and the quality of the amplified signals it produces. ●

**SONY TA-F80 AMPLIFIER**

| | |
|---|---|
| *Dimensions:* | *430 mm wide x 410 mm deep x 160 mm high* |
| *Weight:* | *9.9 kg* |
| *Manufactured in:* | *Japan by Sony Corporation* |
| *Price:* | *$1499.00* |
| *Distributed by:* | *Sony Australia Pty Ltd 453 Kent St, Sydney.* |



MEASURED PERFORMANCE OF SONY TA - F80
S.N. 201992

FREQUENCY RESPONSE:

(-3dB re 1 Watt, 0.5V Input to Aux) Left 1 Hz to 100kHz, Right 1 Hz to 100kHz

Tone Controls Defeated

Tone Controls Centred

Left 8 Hz to > 100kHz
Right 8 Hz to> 100kHz

SENSITIVITY:

| (for 1 Watt in 8 Ω ) | Left | Right |
|---|---|---|
| AUX | 14mV | 14mV |
| TUNER | 14mV | 14mV |
| TAPE | 14mV | 14mV |
| PHONO M/M | 252 µV | 250 µV |
| PHONO M/C | 12 µV | 12 µV |
| OVERLOAD M/M | 360mV | 350mV |
| OVERLOAD M/C | 17mV | 17mV |

INPUT IMPEDANCE:

| | Left | Right |
|---|---|---|
| AUX | 50k Ω | 54k Ω |
| TUNER | 50k Ω | 54k Ω |
| TAPE | 50k Ω | 54k Ω |
| PHONO | 46k Ω | 47k Ω |
| | (100pf/50k Ω ) | |

OUTPUT IMPEDANCE: 43 milliohms (@ 1kHz)

DC on output line Left 50mV, Right 50mV

HARMONIC DISTORTION:

(A) (At Rated power of 120 Watts into 8 Ω = 31 Volts)

| | 100Hz | 1kHz | 6.3kHz |
|---|---|---|---|
| 2nd | -54.1 | -86.2 | -85.1dB |
| 3rd | -59.6 | - | -91.9dB |
| 4th | -96.7 | - | -91.2dB |
| 5th | - | - | -dB |
| THD | 0.007 | 0.005 | 0.007% |

(B) (At 1 Watt into 8 Ω )

| | 100Hz | 1kHz | 6.3kHz |
|---|---|---|---|
| 2nd | -83.4 | -87.3 | -85.9dB |
| 3rd | -88.9 | -96.1 | -87.6dB |
| 4th | -97.0 | - | -dB |
| 5th | - | - | -dB |
| THD | 0.008 | 0.005 | 0.006% |

TRANSIENT INTERMODULATION DISTORTION: < 0.1%

(3.15kHz square wave and 15kHz sine wave mixed 4:1)

NOISE & HUM LEVELS:

| (re 1 Watt into 8 Ω ) (with volume control set for 1 Watt output with,) | | |
|---|---|---|
| AUX | -79 dB (Lin) | -81 dB(A) |
| PHONO M/M | -75.5dB (Lin) | -80 db(A) |
| PHONO M/C | -72 dB (Lin) | -78 dB(A) |

0.5V input (Aux)
5mV input (Phono M/M)
0.5mV input (Phono M/C)

MAXIMUM OUTPUT POWER AT CLIPPING POINT:

(IHF -A - 202)
(20mS burst repeated at 500mS intervals) 89 V P-P

= 124 Watts

Dynamic Headroom = 0.1 dB (re 120 Watts)

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**Applications close 3 July, 1981**

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| Canberra: | 82 2333 | Sydney: | 212 1011 |
| Hobart: | 34 7077 | Townsville: | 71 3191 |
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State: _____ Postcode: _____

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RCOT.455.FP.31.ET

# You're somebody in Today's Air Force

Authorised by Director-General Recruiting Dept. Defence RCOT.455.FP.31.ET


Pioneer have opted for the Philips laser-read videodisc system. No doubt you would too — if model Kerry Healey made the invitation!

# Videodisc — waiting in the wings

The battle lines have been drawn, the software is being sorted out and World War III (for the domestic videodisc market) appears to have commenced with test market skirmishes over the horizon. Be ready for when they strike up the Colonel Bogey march!

**Brian Dance**

DISCS WERE WIDELY USED for audio recording long before magnetic tape recorders became widely available. The pattern has been completely reversed in video recording with video tapes and cassettes available whilst we still await the first commercially available videodiscs! However, the battle for the videodisc market is rapidly heating up with two systems expected to be available by late 1981 and a third system in 1982.

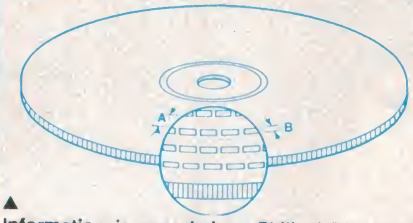
The videodisc market is believed to be extremely attractive and more and more manufacturers are deciding to take part in its development. Indeed, the US consultants Arthur D. Little produced a report recently in which they forecast that, within three years, videodisc machine production should exceed that of video cassette recorders.

They expect that over half of American homes will have a video disc player by this time.

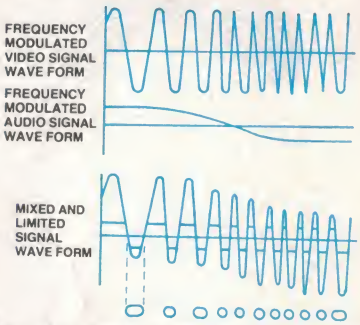
## Laser-optics system

The Philips/MCA system is handled by Magnavox and Pioneer in the USA and the unit comes with a price tag of US$750. The surface of the 300 mm (12") disc is covered with a reflective coating into which tiny pits only 600 nm wide by 100 nm in depth are burned by a laser. (For comparison, a human blood cell has a diameter of about 8000 nm!) A small helium-neon laser is used to read information from the spiral tracks of the disc on playback. Each disc has 54 000 tracks and each track contains the information for a single picture frame. The tracks are 1.6 $\mu$m apart on a 2.5 $\mu$m pitch, the disc rotating at 1800 rpm to provide a playing time of up to 30 minutes. However, it is possible to extend the playing time to one hour per side of the disc by adjusting the speed of rotation in proportion to the decreasing circumference, the track being read so that the laser tracks the disc at a constant linear velocity.

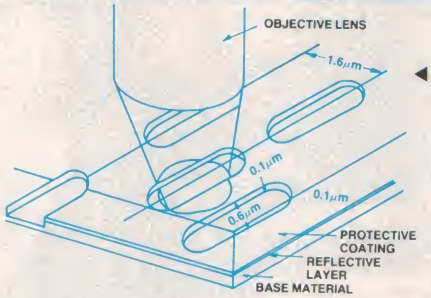
The Philips playback system requires ▶



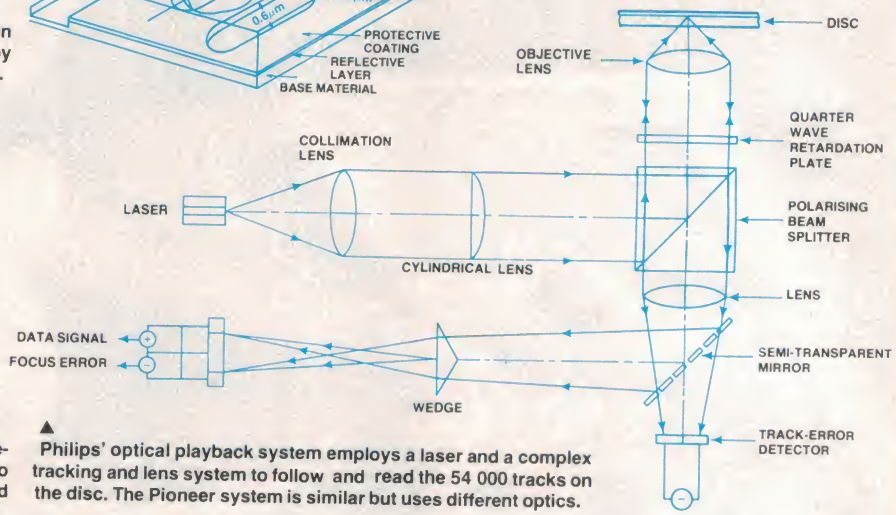

▲ Information is encoded on Philips' Discovision disc as tiny pits only 0.6 $\mu$m wide (dimension B) by 0.1 $\mu$m deep, spaced 1.6 $\mu$m apart (dimension A).




▲ The optical pulses from the micropits are demodulated to produce both video and audio carrier signals, which are subsequently converted into picture and sound.




◀ A laser reads the *length* of the microscopic pits, which contains the encoded information.




▲ Philips' optical playback system employs a laser and a complex tracking and lens system to follow and read the 54 000 tracks on the disc. The Pioneer system is similar but uses different optics.

precise tracking of the laser spot beam together with servo control and time base correction to account for any warping of the disc. It is claimed that the laser modulated discs provide optimum picture resolution together with a long life, while the pits provide very high information storage density. The video blanking bandwidth can exceed 8 MHz. It seems likely that this system may offer sharper images than capacitive tracking systems.

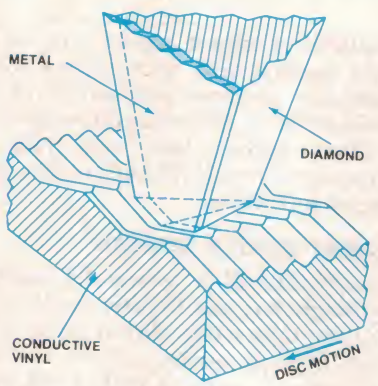
## RCA System

The RCA Selectavision system employs a metal electrode attached to the back of a diamond stylus with a 5 $\mu$m x 2 $\mu$m tip. This stylus follows the track of a groove cut in a vinyl disc which is electrically conductive and utilises the capacitance variations arising from small depressions (known as 'pits') at the bottom of the groove. These changes in capacitance are employed to modulate the amplitude of a composite frequency carrier which is subsequently decoded and fed into the aerial terminals of a television receiver.

It is claimed that this capacitive stylus system offers the principal advantages of low cost and ease of manufacture. The selling price of the RCA type players has been forecast to be less than US$500 in the world markets. This may make it the cheapest videodisc system to become available in the fairly near future, although with a launching date in the world markets of 1982 (and probably somewhat earlier in the USA), it will probably be the latest system to appear in the videodisc race.

### STOP PRESS!

**Philips NV of the Netherlands, which with its American partner MCA was first to market a videodisc player in the US, will also be the first to do so in Europe. The company plans to start selling a PAL version of its optical player in the UK this spring with 100 titles in its catalogue. That number will be doubled during the first year, Philips' officials insist. Meanwhile Thorn EMI Ltd, the UK champion of the video high-density capacitive grooveless disc developed by Victor Co. of Japan, will ready a plant for producing master discs from tape this year in preparation for a 1982 launch of VHD players in that country. RCA Corp, the third main competitor, also plans to have PAL and Secam versions of its Selectavision players on the market in 1982.**




RCA's Selectavision system uses a metal-diamond composite stylus running in modulated grooves on the disc. The stylus tip is only 5 $\mu$m by 2 $\mu$m and the groove pitch is 2.6 $\mu$m. Wear is said to be its biggest problem.

The RCA system employs grooves on a 2.6 $\mu$m pitch so that a 300 mm disc rotating at 450 rpm will provide up to an hour's playing time per side. No tracking control mechanism nor a servo-controlled loop is required in this system. The main disadvantages are stylus wear, which is understood to limit the life of the capacitive pick-up to some 500 hours of playing time, and the relatively limited video and audio bandwidths. The luminance bandwidth is quoted as 3 MHz and the chrominance bandwidth as 500 kHz, while the audio bandwidth extends to 15 kHz (being encoded onto the disc with 716 kHz and 905 kHz carrier signals).

## JVC system

The Video High Density (VHD) system is also a capacitive pick-up type, but does not depend on grooves in the disc for guiding the movement of the stylus across the disc. Capacitive encoded tracking information is included on the disc alongside the video programming information. The stylus does not move in a groove, but sits on the smooth surface of the disc. Minute indentations or pits provide capacitive variations to the pick-up which translates them into electrical signals. Movement of the stylus is controlled by a servo-mechanism which uses the tracking information encoded on the disc.

The VHD capacitive system provides a luminance bandwidth of about 3.1 MHz and includes a full video carrier pedestal up to 6.6 MHz. The audio bandwidth extends to 20 kHz with a signal-to-noise ratio of 60 dB.

## THE DEVELOPMENT OF VIDEODISCS

Since they are only just about to be marketed, you might think that research into videodiscs has only been going for a few years. But as long ago as 1928 John Logie Baird demonstrated his "Phonovision" disc and in 1935 discs for use with the low definition Baird television system were on sale in London. They played for about six minutes per side, revolving at 78 rpm, and used a thorn needle (of a type used in some audio discs of the time) to detect a low bandwidth signal recorded in the groove modulations. They didn't catch on!

There are severe technical problems associated with the development of a high resolution videodisc system and several manufacturers have had to drastically revise their estimates of when their systems would be ready. Philips, for example, said in 1974 that they expected to be able to market their optical system later that same year.

The choice of a basic videodisc system appears to lie between mechanical, optical, capacitive and magnetic pick-up systems. Many attempts have been made to develop each of these basic techniques into a practical system.

The idea of using a mechanical pick-up was not abandoned after the failure of the earliest videodisc systems. A "Teldec" system developed by Telefunken in Germany and by Decca in England was introduced in 1970, but it was not on the market for long because of the very limited playing time of about 5 minutes per side. The disc rotated at 1500 rpm, contained one complete interlaced picture per revolution and was lifted upwards by air pressure so that it came into contact with the pick-up head. Good picture quality was obtained by the use of frequency modulation of the recorded signal.

The best known optical system is the Philips/MCA VLP (Video Long Play) contactless technique discussed elsewhere in this article. However, other manufacturers have carried out a more limited amount of work on optical systems. In particular, Hitachi has developed a technique using a 305mm diameter disc rotating at only 6 rpm. The luminance, chrominance and sound signals are recorded on the disc in the form of 1mm diameter holograms. A small laser is used to scan the disc on replay. It remains to be seen whether any optical technique will ever be evolved which will provide both recording and replay facilities to the domestic user, but little work yet seems to have been done on this problem. Optical techniques would become much more viable if it became possible to use semi-conductor lasers.

Magnetic videodisc techniques may offer the best solution to the problem of providing recording and replay facilities to the domestic user at the present time. There are some systems using magnetic discs marketed for the professional broadcaster which re-record on a magnetic disc continuously. The maximum storage time is less than a minute, which makes them very suitable for action replays in televised sports events, but not for very much else. Great efforts have been made to develop other magnetic disc systems for the consumer market, but nothing has yet materialised. One system developed in the early 1970s using a 305 mm diameter disc gave a total playing time of nearly an hour for the two sides, but was never produced commercially.


**Dave Daly, Vice President of RCA, has every reason to look confident. Their Selectavision system was first on the market, and at the lowest price. But it has fewer features than the competing systems.**

The video signal-to-noise ratio is quoted as 42 dB.

The life of the stylus is of the order of 2000 hours (four times that of the grooved RCA system), but the servo mechanism required raises the cost of both the discs and of the equipment.

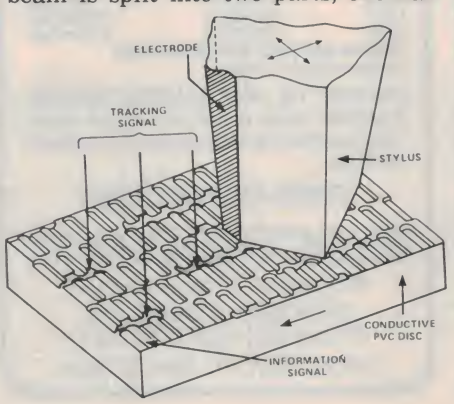
The discs are somewhat smaller than used in the Philips and RCA systems (260 mm dia.) and revolve at 900 rpm

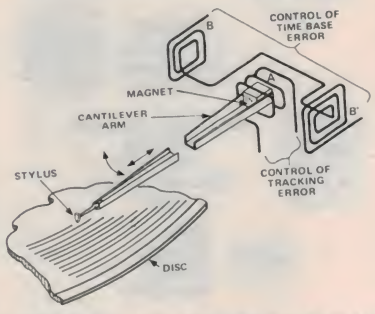
This system has been developed by the Japanese Victor Company (JVC) and will be manufactured in the USA by General Electric Company and by Thorn-EMI in Europe; Matsushita of Japan is also involved. Although the first discs are being made in Japan, Thorn-EMI is trying to establish a plant in England for disc manufacture and GE are likely to manufacture discs in the USA. Players for these videodiscs can also replay suitable digital audio discs.

The VHD system provides access to any point randomly chosen on a disc more quickly than those systems in which the stylus must follow some form of groove. It can provide special effects such as a still picture, fast or slow motion replay, etc. It is rather remarkable that the discs can be manufactured using existing audio disc pressing equipment.

In the recording process for the production of the master disc, a single laser beam is split into two parts, one half being used for recording the information and the other half being used to record the tracking signal. The master disc is made of glass coated with a photosensitive material and the recording must be carried out in a dust-free room. The laser beams are moved along a radius of the disc at constant speed, whilst the disc rotates at 900 rpm. Fine pits are thus recorded spirally on the glass disc which is then used to make a metallic master disc by the conventional process used for audio recordings.

The VHD discs sold to consumers are of conductive polyvinyl chloride (PVC) and have a life of some 10 000 playings. A sapphire stylus is employed, this stylus being mounted at the end of a cantilever arm with a magnet on the opposite end. Fixed coils are mounted near to the magnet and a single coil is wound around (but not in contact with) the magnet. In addition, a pair of vertical coils are mounted on either side of the single coil in phase opposition to one another. This arrangement enables ▶




**The VHD system from JVC employs a capacitive pickup system reading microscopic pits in the conductive plastic disc, tracking signals encoded on the disc providing information to a servo system that drives the stylus across the disc. Stylus life is said to be around four times that of the RCA system.**

**A Matsushita executive demonstrates the VHD system at last year's Consumer Electronics Show. It takes a vinyl disc that must be loaded with a caddie like the RCA system, but it has stereo (an add-on) and offers random access, freeze-frame etc.**

the stylus to be moved transversely and longitudinally as the current flowing in the coils varies. The coil currents are controlled by the tracking error signals and timebase error signals. However, a command to move the stylus to a particular track can also be used to control the coil current.

JVC claim that their use of a relatively conventional disc production technique is a great advantage of their system over optically based videodisc systems.

Thorn's recent acquisition of the EMI group of companies opens up an enormous source of film and record material for this Japanese-UK-US group to use in video and digital audio discs encoded in the JVC standard. The availability of suitable software (video and audio material) will play a vital part in the success or failure of videodisc systems.

Matsushita (who market Technics and Panasonic products) have decided to abandon their own videodisc system in favour of the JVC system and have now made an agreement with JVC. The original Matsushita system employed a direct contact stylus and a rigid disc.

## Conclusions

It seems probable that the three incompatible videodisc systems will exist side by side at least in the early 1980s, so this could mean that people who want to be able to play any videodisc will be involved in expensive investments.

In spite of the current interest in videodiscs, one must remember that people will not want to replay their favourite videodisc as often as they play their favourite audio discs and this may well affect the chances of videodiscs attaining the widespread use essential for their success. However, if a wide range of material is available on disc at reasonable prices, it seems certain that there is a pretty good market for high quality systems.

The picture quality provided by videodiscs is certainly superior to that from domestic video cassette recorders. The most expensive videodisc system (Philips) will be cheaper than videotape systems (apart from its better quality pictures) and will be one of the most flexible disc systems. The JVC system offers the highest storage density of any of the videodisc systems.

It is interesting to note that videodiscs are no longer limited to the domestic consumer market. Videodiscs are very suitable for the storage of computer type information and it could well be that this application will help enormously to spur on manufacturers to invest more heavily in videodiscs generally, since there is also an enormous potential market in the business and other data storage computer fields. When compared with conventional magnetic recording techniques for digital data storage, videodiscs offer greater bit densities (with storage capacities of around $10^{10}$ bits per disc surface), virtually error-free recording, probably lower cost per stored bit and a true archival storage capability in which the recorded data is unalterable.

One of the most interesting developments from the business world came in news released from Drexler Technology (one of the leading companies in Silicon Valley) in May 1980 about a 300 mm disc system intended for use as a computer memory device which can easily be recorded upon as well as played back. Drexler claims that by early 1982 two-sided discs produced in quantities of 100 000 or more will be able to store 2500 Mbytes at a cost of about two cents per Mbyte. Drexler state that this may be compared with current costs of 40 cents for tape cartridges or about $3 for magnetic discs and several hundred dollars for magnetic bubble memories. Drexler also claims that 20 000 document copies could be stored on a disc at a cost of ¼ cent per copy for use in an electronic filing system! This type of disc, known as the Drexon D-1201, is the first of its kind to become commercially available and will sell for $3500 per disc in quantities of 20.

Also announced in May 1980 was an agreement between Xerox and Thomson CSF for the development of optical disc systems for data processing.

Other companies, including Philips and IBM, are also entering the videodisc business field. It seems certain that activity in this field will sooner or later be a helpful stimulus to the consumer field. Indeed, it may well be that the days of the conventional floppy disc are numbered and that the consumer and business videodisc markets will be able to teach the computer world a thing or two! ●

### COMMERCIAL APPLICATIONS

Pioneer Electronics Australia is to provide GMH with its laser technology videodisc system for use as a communications medium for GMH dealers. This makes Australia the first country outside North America to adopt videodisc technology in a commercial application on any large scale.

The videodisc will replace 'live' training and promotional services and obviate the need for dealers to attend regional and national conferences and seminars; all new product information and sales and promotional instruction will be distributable on videodisc.

The GMH Video Centre, as the system is called, consists of a Discovision 7820 industrial laser videodisc player (produced by Universal Pioneer Corporation),a TV monitor and optional Pioneer sound system. Features of the 7820 videodisc are fast visual scanning in both forward and rewind modes, single frame display and chapter search.

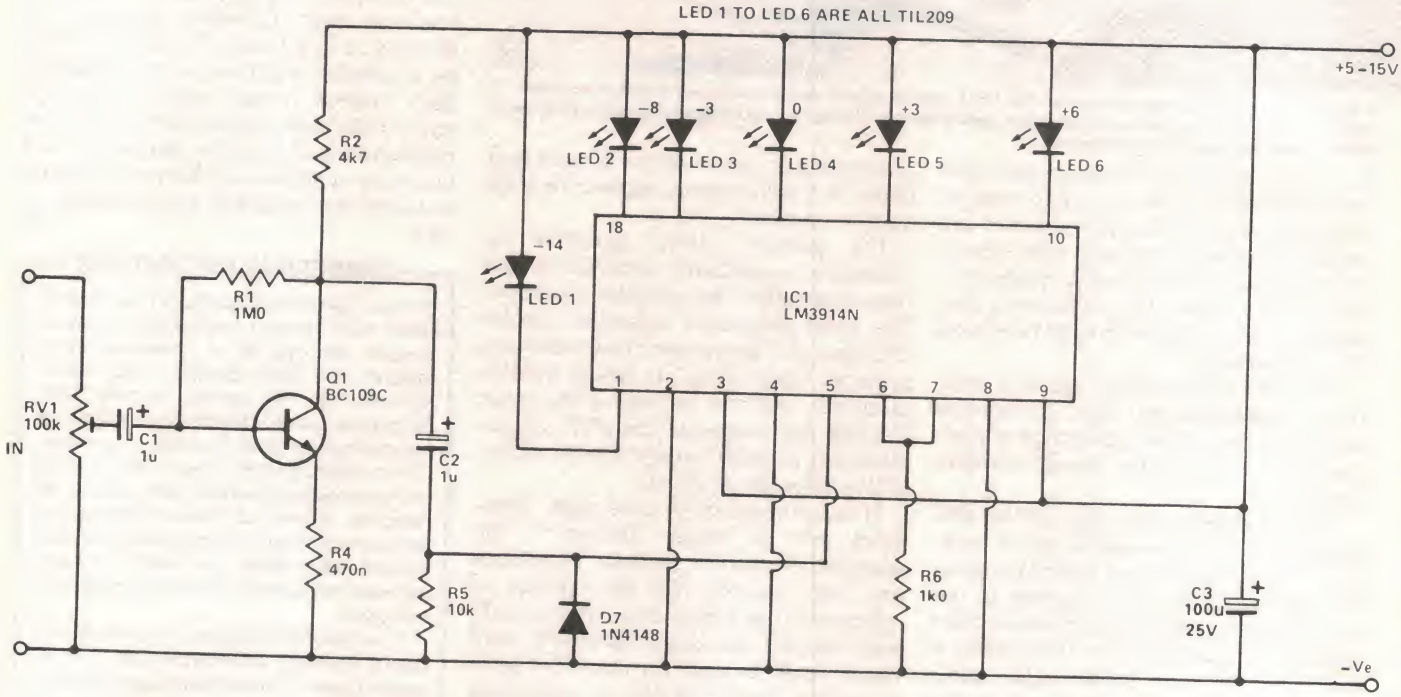
The software for the GMH Video Centre is made to master-tape stage in Australia by AAV and then sent to Discovision Associates in the US, where the image is transferred to disc.

General Motors in the USA and Canada have already used the laser videodisc throughout their domestic dealer network, and GMH will be able to use any relevant North American material as well as their own Australia-oriented videodiscs.

The complete Video Centre sells to GMH dealers for under $4000, and orders are currently being taken from dealers for installation in May this year.

Pioneer regard this new commercial application of the laser communications medium, which they claim to be "the most advanced method of communication ever", as a highly important step in the progress of the laser videodisc system.

# Simple LED VU meter covers 20 dB range in six steps




THIS VERY SIMPLE peak reading VU meter circuit uses six LEDs to indicate six signal levels. Indicators are provided at −14, −8, −3, 0, +3, and +6 dB or any other levels having the same spacing (e.g: −17, −11, −6, −3, 0, and +3 dB, if preferred). Only about 24 mV peak-to-peak is needed in order to activate the highest LED indicator, and so the circuit is sufficiently sensitive to be used with any normal item of audio equipment.

The circuit is based on an LM3914N bargraph display driver device (IC1), which can be used to drive up to ten LEDs. This is connected so that with 0.12 V at the input only the first output is activated (goes low). With the input raised to 0.24 V the second output is activated as well, 0.36 V activates three outputs and so on up to an input of 1.2 V or more whereupon all ten outputs are activated. In this circuit only LEDs 1, 2, 3, 5, 7, and 10 are included in the display, and these are LED1 to LED6 respectively.

The input signal is taken to a variable attenuator (R1), which enables the sensitivity of the circuit to be set at the correct level. The signal is then passed to a low gain common emitter amplifier based on Q1 which gives a tenfold boost in the sensitivity of the circuit, and ensures that it is adequate in this respect for all normal requirements. C2 couples the output from Q1 to the input of IC1. R5 is the input bias resistor for IC1, and D7 protects IC1 against an excess negative input voltage. Of course, IC1 only responds to the positive half cycles at its input, and this gives generally satisfactory results in practice. R6 sets the current fed to each LED at about 12 mA, but as the circuit only responds to positive input half cycles the LEDs can switch on for a maximum of about 50% of the time. This gives an effective LED current of about 6 mA. The quiescent current consumption of the unit is about 8 mA, rising to an absolute maximum of about 44 mA with all six LEDs activated.

To calibrate the unit a 0 dB test signal should be fed into the monitored equipment, and R1 is then adjusted for the lowest sensitivity that does not cause the 0 dB LED to extinguish. The input impedance of the unit is about 80k and it will only lightly load the monitored equipment if the source impedance is 10k or lower. ●

SHORT CIRCUITS is a feature that lies somewhere between Ideas for Experimenters and complete Projects. Generally, the items published in Short Circuits will involve tried circuits that have not necessarily been fully developed, but fairly complete details are included as a guide to readers. Unfortunately, owing to the nature of these items, we cannot give further details other than what is provided in the article. Contributions for Short Circuits are always welcome.

# Dick Smith's P-360 turntable

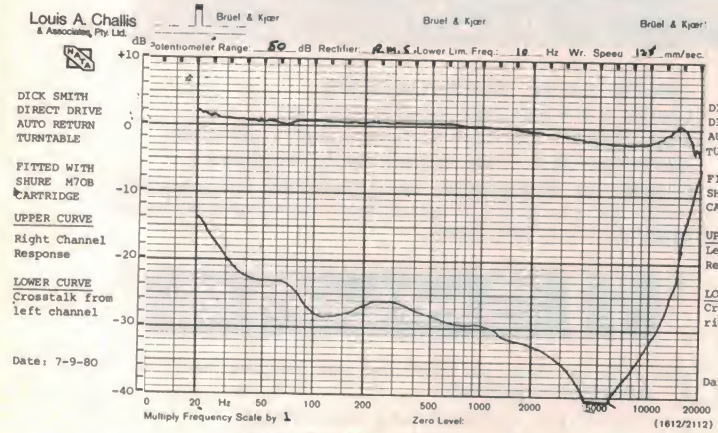
For a reasonably priced turntable, Louis Challis found Dick Smith's P-360 model to be good value for money, needing only a high-quality cartridge for top performance.

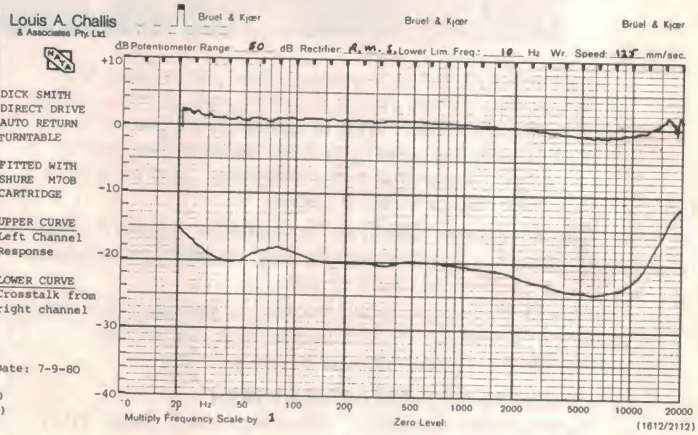
**Louis A Challis**

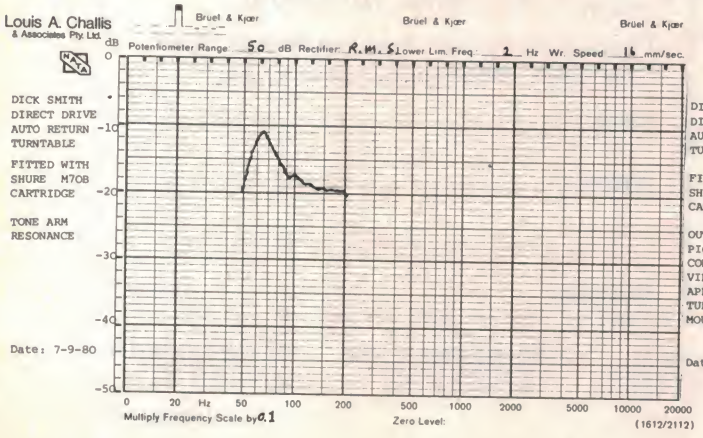
THE P-360 is a neat turntable providing many popular features, such as direct drive in preference to belt or rim drive and most particularly an auto return function. The direct drive incorporates a Matsushita Electric DCL-15U1 motor system; this large-selling motor is often chosen by manufacturers when they do not wish to develop and manufacture their own. This motor and drive are rigidly screwed to a particle board and ply-fabricated plinth, which is well finished in a metallic lacquer to give the appearance of a metallic or plastic moulding. The unit also incorporates a removable single-piece acrylic moulded cover with spring-loaded hinges which slip into sockets at the back of the plinth.

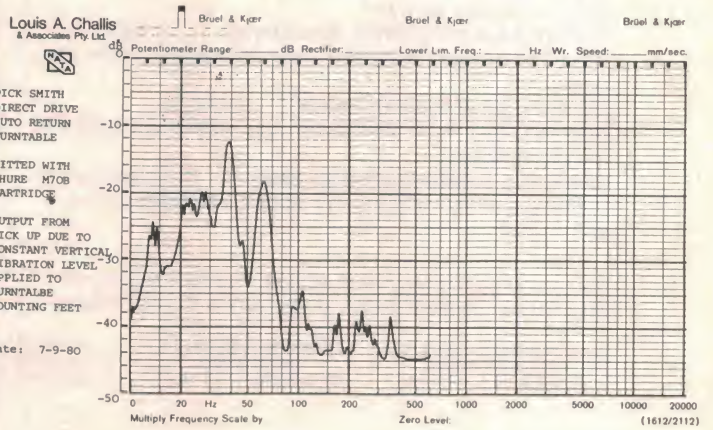
## Features

The number of controls provided for the turntable are minimal, the left hand side of the deck featuring two knurled speed controls for 33⅓ and 45 rpm, adjacent to which is a pedestal incorporating a strobe light approximately 20 mm from the edge of the platter rim. The rim incorporates four separate




strobes for 33⅓ and 45 rpm and for 50 Hz and 60 Hz respectively. This of course blows Dick's statement that "this unit has been designed for Australia", but did anyone really believe that anyway?

On the right side of the plinth are two buttons, the one on the left providing for selection of 45 and 33⅓ rpm whilst the one on the right is a cut control to terminate the playing of a record before the end of the selection. Behind the speed selection and cut control is a strange knob incorporating an extended aluminium arm, whose function is to initiate the play sequence. Immediately behind this is the tone arm rest and the S-shaped tone arm, integrally mounted in its own black escutcheon. The escutcheon provides an oil-damped tone arm lift control, spring-activated anti-skate control setting and a well-designed and reasonably light tone arm assembly, complete with balance weight designed to provide up to 3 grams of static balance.

The turntable platter is a solid die casting from aluminium alloy, which weights 1.45 kg. This is surmounted by a rubber mat to give a small degree of additional damping. The plinth is supported by four rubber and plastic mounts to supply a small degree of vibration isolation to compensate for only 2 mm static deflection. Under the platter is a lever provided with seven slots to allow for variations in the speed of the tone arm movement when cueing onto or returning from the record. This is one function which is not normally user-selectable and does add a degree of flexibility.

The head shell on the tone arm features an EIA plug-in connector and the unit tested had a universal head shell already fitted, in this case with a Shure M70-B cartridge.

## On test

The objective testing of the basic turntable and tone arm showed it to have performance characteristics which ranged between good and excellent. The wow is 0.1% peak to peak, the flutter 0.04% weighted rms and .08% unweighted, whilst the rumble is −65 dB weighted — which is bordering on excellent.

The cartridge fitted has a frequency ▶

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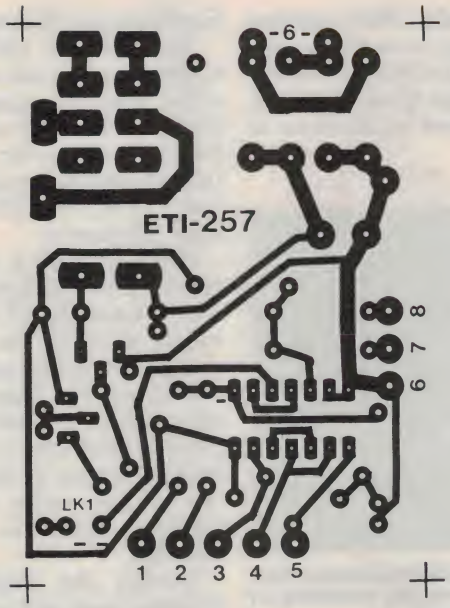


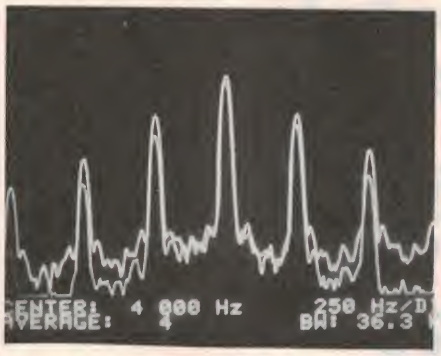

**Artwork for the pc board for the ETI-257 Universal Relay Driver Board (see pages 53-55).**

response extending from 20 Hz to 20 kHz ±2 dB for the left channel and 20 Hz to 18 kHz ±2 dB for the right channel. Channel separation is better in the right channel than in the left, this being a function of the anti-skating control as much as of the cartridge itself. The tone arm resonance exhibits a fairly sharp "Q" at 6.5 Hz and thus falls below the preferred 9-10 Hz frequency I would recommend to minimise rumble components generated by warped records, although it is still below the expected range of recorded content.

The degree of vibration isolation is not as good as I would like, with a significant resonance at 40 Hz and a second resonance occurring at 62 Hz.

With resonant frequencies of this order there would be a reasonably strong likelihood of the unit being affected by either building vibration or acoustical feedback from the loudspeakers under adverse conditions. The unit would need to be carefully located in order to preclude this possibility and Dick Smith would be well advised to arrange for future units in which the rubber mounts provide a greater static deflection. Another alternative would be to provide supplementary isolation mounts, but this of course adds additional unwanted expense.

The harmonic distortion of the M70-B cartridge with which the unit tested was fitted was significantly higher than normal, with distortions as high as 2% on the left channel at 100 Hz, 3.6% on the right channel at 1 kHz and 11% on the left channel at 6.3 kHz. Whilst the cartridge tracks to the second highest level of the Shure TTR-103 test record reasonably well, at the 30 cm/s velocity it completely mistracks. This indicates that a better cartridge is really needed, and one would be well advised to select a high quality cartridge in keeping with the basic performance capabilities of the record player.




**Measured performance of Dick Smith direct drive auto return turntable showing the trackability on the Shure TTR-103 test record.**

## In use

In practical use at home with a range of alternative cartridges, including a Shure V-15 Mark III, a Shure M-95ED, an Ortofon VMS20E Mark II, and an Audio Technica AT-30E, the record player provided excellent performance in which it only slightly modified the basic capabilities of the cartridges with which it was used. The 6.5 Hz resonance did not appear to be a problem, except with warped records, and the wow, which is a little higher than desirable, also does not constitute a serious problem.

The speed adjustment capability provides sufficient range to suit those special occasions when users would desire to either increase or decrease the playing speed from the normal speed.

The starting and stopping of the record player is not as quiet as in many units, and in a quiet room positively detracted from the otherwise good performance. However, on the whole the unit appears to be ruggedly constructed and this is probably more important to most purchasers.

When playing a series of direct-to-disc records and digital records, most of which have signal to noise ratios in excess of 70 dB, the rumble and wow and flutter generated by the turntable were inaudible. When mounted close to the speakers or when resting on a record playing rack sitting on a wooden floor there is a trace of feedback, indicating the need for more effective vibration isolation than the current system provides.

Overall the P-360 record player provides good performance at a reasonable price, and only lacks the addition of a first-class cartridge in order to develop its full potential. ●

**DICK SMITH P-360 TURNTABLE**

| | |
|---|---|
| *Dimensions:* | *443 mm wide x 346 mm deep x 145 mm high* |
| *Weight:* | *7 kg* |
| *Manufactured in:* | *Taiwan* |
| *Price:* | *$199* |
| *Distributed by:* | *Dick Smith stores* |



MEASURED PERFORMANCE OF

DICK SMITH DIRECT DRIVE AUTO RETURN TURNTABLE
CAT A - 3078 - MODEL P-360 (Serial No. 000234)
FITTED WITH SHURE M70B CARTRIDGE AS SUPPLIED

WOW AND FLUTTER

| | |
|---|---|
| Wow | 1.0% peak to peak |
| Flutter | 0.04% weighted RmS<br>0.8% unweighted RmS |

RUMBLE

-65dB weighted (BS4852)
-38dB unweighted

SENSITIVITY

| | |
|---|---|
| Right Channel | 1.9mV/cm/sec |
| Left Channel | 1.5mV/cm/sec |
| Channel difference | 2dB |

FREQUENCY RESPONSES

20Hz-20kHz

CROSSTALK

| | 100Hz | 1kH | 6.3kHz |
|---|---|---|---|
| Left into Right | 29dB | 32dB | 37dB |
| Right into Left | 20dB | 21dB | 23dB |

TONE ARM RESONANCE

6.5Hz (see attached graph)

TOTAL HARMONIC DISTORTION

(2.24cm/sec @ 1kHz)

| | 100Hz | 1kHz | 6.3kHz |
|---|---|---|---|
| Left | 1.9% | 2.6% | 9.8% |
| Right | 1.5% | 3.6% | 11% |

TRACKABILITY

(Using Shure Disc T+R103 400 and 4000Hz)

Tracks all levels except 30cm/sec at 2.5 grams.
Photo shows distortion components (Including those of disc) at 24 and 30 cm/sec.

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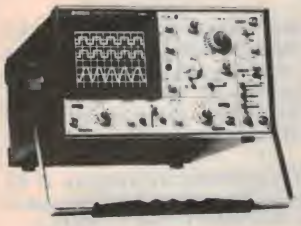

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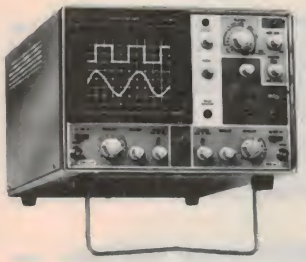

## V302 30 MHz — $955

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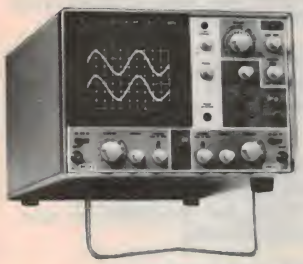

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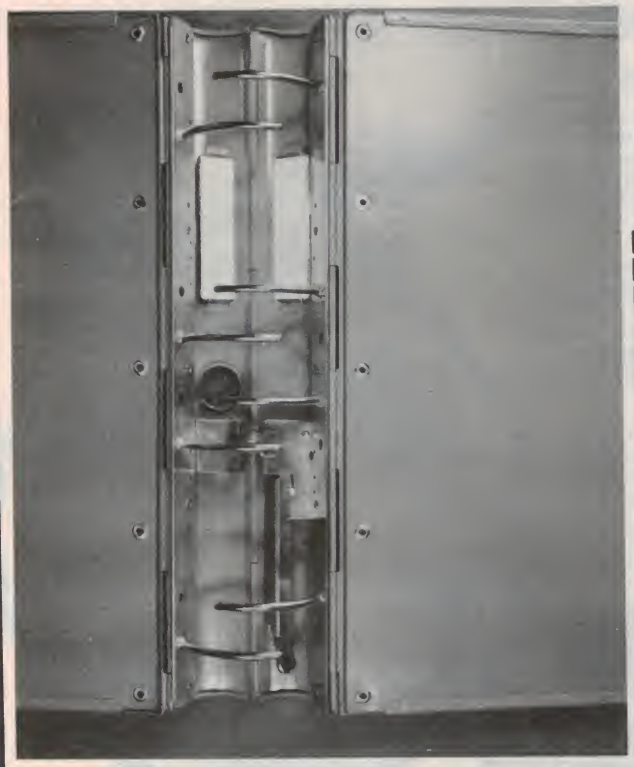

## HERE IS A MOST UNUSUAL SPECIAL OFFER.

**Our company has for sale 1500 of the most superbly made binders you've ever seen in your life!**

We bought them for a data service which has since closed down. They are specifically intended to hold data sheets and similar material which must be referred to constantly. All those for sale are brand spanking new — but we can show you some old ones that have been in constant hourly use for over 20 years and they are still as new!

We know this sounds like hyperbole, but these devices can only be described by using superlatives. They're made (like a Rolls-Royce!) by the Swedish company Aggripa.

For example, the hinge assemblies are made of heavy-gauge plated steel. The spine and all outer edges of the covers are heavy-gauge enamelled steel. Apart from the steel hinges holding the covers, the spine itself is hinged down the centre, enabling the binder to lie completely flat for easy insertion and removal of material.

As may be seen from the pix, material is held in place by an eight-hole pin mechanism — actuated by a remote control trigger at the bottom of the spine.

**These binders are ideal for housing valued reference material, data sheets, etc, etc.**

These binders are not normally obtainable in small numbers — if they were the retail price would be at least $25 each.

**We are offering them *exclusively* to ETI readers for the absolute bargain price of $10 each (plus $2.00 post and packing). See also inset table for quantity prices.**

These binders may be inspected at our Sydney and Melbourne offices during normal working hours.

## UNCONDITIONAL MONEY-BACK GUARANTEE.

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# Dregs

A COUPLE OF MONTHS ago Dregs asked readers to send in examples of names matching occupations. We've had quite a response, including a whole list from C. Hignett of Kirwan, Qld, who acknowledges the UK Sunday Times as the publishers of the original list but thought they were worth reprinting anyway. Here goes:
Messrs Doolittle and Dalley - Estate agents.
Messrs Welsh and Robb — Solicitors
Dr Dottie — Psychiatrist
Mr Smellie — Sanitary inspector
Mr Cheater — Tax inspector
Mr Boddy — Undertaker
Mr Graves — Cemetery caretaker
Police Constable Caution
Messrs Plummer and Leek — you guessed it!
Plus a whole family called Snoring who live in the village of Gotobed.

Craig Air of Belrose, NSW, also wrote to tell us of teachers at his school whose names match their subjects: there's Mr Weldon, the metalwork teacher, Mr Levy, the commerce teacher, Mrs Tucker, who teaches cooking, and a music teacher by the name of Mrs Organ. Craig reckons it's all one of the Ministry of Education's new schemes for helping new Year 7 students find their way around the school — he could be right.

And our typesetter here at ETI tells us of her mother's chiropodist, a lady called Miss Trotter, who lives at Randwick — which of course is where the racetrack is!


**Wayne Canteli, Editor of sister journal Modern Motor, clowning around at the Fleurs antenna test range of Sydney University (at Kemp's Creek) during measurement trials of vehicle radar cross-sections for our March issue lead article on Police Radar Traps.**

## Pun punts

February's puns occasioned a rush of creativity (??), or maybe that should be a rash . . . Anyhow, away we go with an entry from James Gallagher of Beecroft, in Sydney. James sent in a number of songs and question-answer puns, but his best effort was a limerick:
There was a technician called John
Who swallowed a 16K ROM
He tried on a buss
But it caused such a fuss
That his bytes performed functions all wrong!

Hot on his heels came an entry from 15-year-old Paul Richardson of Redcliffs in Victoria. He had two question-answer puns, again on a computing theme. His best (?) was:
Q: What does a shepherd have in common with a computer?
A: They both have rams!

Then Bert Hansen sent in one that would have the Commissioner for Community Relations, Mr Grassby, after us if we printed it. Sorry Bert. However, this month's prize pun came from B.P. Dilworth of Curre King Island, off Tasmania. Apart from sending two dozen puns, Mr Dilworth sent us a dozen or so cartoons. We might get round to the cartoons some other time. His winning pun combined a literary and computing theme! If Shakespeare had discovered Boolean Algebra before Boole did, perhaps Hamlet's famous soliloquy would have turned out: BB or $\overline{BB}$ !

Your copy of Computers & Computing is on its way, Mr Dilworth.

Our Managing Editor, Collyn Rivers, punster extraordinaire, thought up a Shakespearean pun ages ago, and your Editor has been seeking an opportunity to embarrass him with it ever since. It's not as subtle as Mr Dilworth's effort, but here it is, anyway:

"Shakespeare, reflecting upon the demise of live music in Elizabethan pubs, was heard to say: 'Now is the winter of our discotheque' "!

At this stage, we should warn readers that this madness has to stop! All good things come to an end, and the Great Dregs Pun Competition will end with the July 1981 issue. After a run of 12 months, it's about time we found some other curiosity to have fun with in Dregs. Get those entries in before 15 May. Don't miss the July issue — new Dregs competition coming up!

# UNTIL WE DEVELOPED THE STEREO GROOVE, HI-FI WAS PRETTY HO-HUM!

The world of hi-fi owes a lot to the original and continuing innovation of JVC. Few companies, if any, have done as much to help turn records and record-players into the virtual musical instruments they are today . . . or to lead the way in developing so many *firsts* in the more recent concepts of sound amplifiers, cassette decks and computer-designed speaker systems. Hi-fi, as we know it today, had its beginnings in 1956, with JVC's development of the 45°/45° groove for stereo records. The fact that this system still remains as the world standard is, in itself, outstanding testimony to the technology of JVC. The development revolutionised not only the record-*making* industry, in which we've been involved since 1930; it also paved the way for enormous advancement in the design and engineering of record-playing equipment. Now, hi-fi has expanded to

R-S77. Super-A FM/AM Stereo receiver

embrace a wealth of highly-sophisticated electronic equipment; and it's not surprising that JVC has continued to play a leading role in so much of its development.

HR-3660 EA. VHS Colour Video Cassette recorder

## THAT WASN'T OUR ONLY FIRST, EITHER.

We also pioneered Japan's television industry, introducing their first TV receiver just over 40 years ago. A more recent innovation is VHS, the home video recording system now gaining world-wide acceptance as *the* system for such equipment. In the course of staying ahead, we've introduced a number of world *firsts* of radical importance: the Quartz Lock turntable is one of them.

## THE QUARTZ LOCK TURNTABLE. MANY TIMES MORE ACCURATE.

It stands to reason that if your equipment is at the top end of the range, then your turntable must be capable of comparable performance. Only Quartz Lock ensures this, tying the speed of the turntable to the unvarying pulse of the atom, and providing a level of accuracy far in excess of conventional turntables.


## MORE MILESTONES IN HI-FI.

To match the superb quality of Quartz Lock, we produced the S.E.A. graphic equalizer system. Then we refined it to such a degree it even compensates for the effect your furniture has on sound when it leaves the speakers! To expand the capabilities of tape, we designed ANRS and

SEA-80. Stereo Graphic Equalizer

Super ANRS — automatic noise reduction systems which not only reduce distortion and 'hiss' but actually extend the dynamic range of the tape. Similarly, with speakers: at JVC we employ computers in their design to help provide the ultimate in sound reproduction.

## AND NOW, SUPER-A.

In its own way, as significant a hi-fi development as the stereo groove. Imagine an amplifier which combines the *best* features of the two recognised amplifier classes (A and B) . . . an amp which combines the *efficiency* of one with the *low distortion* of the other. Some engineers said it couldn't be done; but not those at JVC. Enter the Super-A amplifier . . . the *latest* JVC *first!*

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## THE FUTURE.

It's already with us. For instance, we were so far ahead in the new metal tape technology that our cassette decks were metal-compatible before the tapes were generally available. And now there's the JVC Electro-Dynamic Servo Tonearm, damping tonearm resonance by means of a purely electronic system and two 'thinking' linear motors. Who was it who dubbed JVC, 'the innovators'?

1861

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